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**THE CONTROL AND PROTECTION OF LAND USES
IN THE VICINITY OF AIRPORTS**

A THESIS

**Presented to
The Faculty of the Graduate Division
By
Frank William Osgood**

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ABSTRACT

The primary purpose of this study is to formulate controls which will eliminate or reduce conflicts between airports and their surrounding land uses through: (1) the protection of airport approaches against the creation of obstructions or hazards to air navigation; and (2) the protection of the legitimate interests of persons and property located in the vicinity of airports without unnecessary interference with the continued development of aviation.

Initially, problems confronting airports and land uses in their vicinity are analyzed. Such existing problems include: (1) airport use by a wide range of aircraft; (2) airport location difficulty; (3) noise; and (4) crash hazard (real or psychological) of aircraft. The effects of saturation of the air and problems resulting from technological developments in aviation are anticipated.

Methods of reducing conflicts between airports and their surrounding land uses are considered next. To reduce or eliminate existing and future problems, the necessity is shown for: (1) airport specialization; (2) proper airport location; (3) the reduction of airport operational noise; (4) desirable surrounding land-use development considering

location, density, structural height and value; and (5) continual adjustment to technological developments in aviation. Desirable land-use patterns around commercial-passenger, commercial-cargo, industrial, general aviation, military and multi-purpose airports are suggested for the inner-approach areas, outer-approach areas, and those areas adjacent to the airports but outside the approach areas.

Finally, planning and legal tools are presented which, when combined, will adequately control and protect land uses in the vicinity of airports. The future land-use plan, which includes a metropolitan or regional airport plan and individual airport site plans, is first considered. To carry out the requirements of the future land-use plan, it is recommended that airport zoning be included in comprehensive zoning on a metropolitan or regional basis. Subdivision regulations may be used to guide the development of residential areas surrounding airports through the enforcement of design and location standards. Land purchase in fee, the purchase of developmental rights, or the purchase of aviation easements over the land are other tools used to protect and control land uses in the vicinity of airports.

Recommendations are made for the strengthening of airport zoning enabling legislation and the development of state planning enabling legislation to authorize the coordination of airports on a state-wide basis. On the Federal

level, recommendations are made to strengthen the Model Airport Zoning Act and Ordinance, and to continue financial assistance for airports through the Airport Act of 1946.

A technique is proposed providing more adequate land-use control in airport approach areas. Crash hazard and noise intensity are the principal criteria for delineating airport approach area boundaries and the desirable land uses within the various zones comprising the approach areas required for three basic types of aircraft.

Methods of coordinating and implementing proper and realistic control and protection of airports and the land uses in their vicinity are then recommended.

CHAPTER I

PROBLEMS CONFRONTING AIRPORTS AND LAND USES IN THEIR VICINITY

Introduction

The successful testing of guided missiles and winning the race for control of outer space are considered aviation's most important goals for national survival. It is probably equally important that existing and future conflicts between airports and their surrounding land uses be reduced to insure the healthful growth of aviation and urban areas through compatible co-existence. The incompatibility of airports with surrounding land uses is not a new situation in the transportation field. The railroad and automobile have faced the same dilemma and have failed to adjust to the urban structure without creating friction, deterioration, and other problems for adjoining land uses.

Problem and Purpose

Increasingly troublesome problems have occurred in the air space surrounding airports. It is a critical area where distractions or limitations resulting from improper land-use development in the vicinity of airports are unusually hazardous to safe flight. Conversely, to the

residents surrounding the airport, aircraft and airport operations are often considered nuisances, hazards, and infringements on the free use of the land. With the rapid spread of urbanization, the tremendous growth of aviation, and the prospect of larger, faster, and noisier aircraft, these conflicts are becoming more complex and difficult to resolve.

Problems resulting from conflicts between the airport's operation and the surrounding land uses will be analyzed. Recommendations will be made for controls which will insure: (1) the protection of airport approaches from obstructions or hazards to air navigation; and (2) the protection of the legitimate interests of persons and property located in the vicinity of airports without unnecessary interference with the continued development of aviation.

Thesis Organization

The first chapter of this thesis will provide an introductory glimpse of the subject with the analysis of problems, both existing and future, confronting airports and land uses in their vicinity.

Airport and land-use development factors which will guide the development of a desirable land-use pattern in the vicinity of airports and answer the problems posed will be presented in the second chapter.

The third chapter will contain the study of existing and proposed legal tools which can be used to control and protect land uses in the vicinity of airports.

The formulation of a technique providing more adequate land-use control in airport approach areas is achieved in the fourth chapter.

Finally, in the fifth chapter, conclusions and recommendations will be advanced which will provide a basis for improving land-use control and protection in the vicinity of airports.

Importance of Adequate Controls

Through adequate controls, conflicts between land uses and airport operations can be resolved, future aircraft and airport developments can be readily accommodated, and the health, safety, and general welfare of all concerned can be protected. This can be accomplished more easily when the area surrounding an airport is still sparsely populated and controls can be applied without difficulty to future developments. A more gradual adjustment to controls is required in built-up areas where there is the difficulty of eliminating or reducing the effect of existing incompatibilities.

Related Problems of Airports and Surrounding Land Uses

The complex problems which either exist today or are expected to occur in the near future will be analyzed in order to explain the reasons for the conflict between airports and land uses in their vicinity. Current problems concern airport use by a wide range of aircraft, improper airport locations, noise, and crash hazard. Saturation of the air and adequate preparation for future technological developments in aviation are problems of the future. If these problems are not solved or reduced sufficiently in scope, aviation's future role in urban life will be affected in two ways. Aviation's rapid expansion and importance as a mode of transportation will be slowed; and aviation will join the railroad and automobile as a perennial blighting influence upon surrounding land uses.

Existing Problems

Existing problems affecting airport operations and surrounding land uses have increased significantly since World War II. In 1946, the number of airports in use was slightly more than 4,000, as compared with a 1955 total of 6,839, an increase of almost 60 per cent in ten years. Between 1950 and 1955, a period of six years during which the

population of the United States increased nine per cent, the four divisions of commercial aviation grew at a much greater rate (revenue passenger mileage, 148 per cent; freight ton-mileage, 55 per cent; air mail ton-mileage, 85 per cent; and express ton-mileage, 38 per cent).¹ These two illustrations are examples of aviation's increasing effect on our urban life, especially in the vicinity of airports.

Four different elements have created difficulties between airports and land uses in their vicinity. These are: (1) airport use by a wide range of aircraft; (2) improper airport location; (3) noise; and (4) crash hazard (real and psychological).

Airport Use by a Wide Range of Aircraft.--When used to capacity, multi-purpose airports have two fundamental weaknesses not found in single-purpose airports. First, there is a waste of traffic capacity; and second, there is a waste of approach-area utilization. These are important points because many new airports have reached their capacity or are inadequate soon after completion, principally because they are being used by all types of aircraft (including the type for which the runways were basically designed to serve).

There is a waste of traffic capacity because of the extremes in aircraft utilizing the airport. An example of

this is a small single-engine aircraft landing and taking-off on a 6,000 foot runway. A military jet aircraft characterizes the other extreme when it also lands and takes-off from the same 6,000 foot runway. Both aircraft are using facilities which are either unnecessarily long or too short, and certainly not designed for them. Assuming that the commercial-passenger aircraft is the principal user, that the airport facilities were designed for it, and that commercial operations are being unduly affected by other aircraft, the airport's traffic capacity is being wasted.

Generally, a small number of the aircraft utilizing a multi-purpose airport either require a longer and wider approach area, or a shorter and narrower approach area than necessary to serve the principal aircraft using the airport. To illustrate, steps must be taken to protect a larger approach area from the effects of the small number of military jets using the airport than would be necessary for commercial-passenger aircraft. A small single-engine aircraft's possible annoyance and hazard would affect a smaller approach area; this would fail to utilize a portion of the approach area which was designed to cope with noise and hazard of commercial-passenger aircraft.

Improper Airport Location.--Several difficulties are involved in properly locating airports. The principal difficulties are: (1) finding a large enough site in an area where the

airport function and aircraft volume will not adversely affect surrounding land uses; (2) locating the airport where accessibility by surface transportation to the airport's users will not adversely affect the surrounding land uses; and (3) locating the airport where its traffic pattern will not interfere with traffic patterns of adjoining airports.

A combination of the following factors has stimulated the decentralization of population from cities into the metropolitan areas, making it difficult to find adequate sites for the various types of airports needed to serve the central city and its metropolitan areas: (1) the automobile which made the city accessible to commuters living in its metropolitan area; (2) suburban living which offered privacy and spaciousness as opposed to the congestion, noise, and dirt of city living; (3) the tremendous growth of population; and (4) the rural to urban movement of population accelerated by the mechanization of farms. The outward movement of population has also created more conflicts between airport operations and the rapidly developing surrounding residential areas and has limited the location and size of the various types of airports.

Unfortunately, there is poor accessibility by surface transportation to many airports today, affecting both the airport's potentiality and the health, safety, and general welfare of the occupants in its vicinity. Not only is an

adequate surface transportation link to the airport important to insure accessibility to its users, but it is also necessary to eliminate needless traffic congestion, noise, and hazard from residential streets in the airport's vicinity and thus help prevent blight.²

As the number of airports increases, the possibility of the traffic patterns of two adjacent airports conflicting with each other is increased if proper separation is not achieved. This difficulty has already taken place in some of the larger cities, lowering the traffic capacity of the affected airports. Proper airport separation will also permit the maneuvering of aircraft within an established air space reservation without risking collision with other aircraft landing or taking off from an airport or from aircraft using adjoining airports.³

Noise.--With the tremendous growth in the use of aircraft and in their increased power, more and more adverse public reaction has been aroused against the noise nuisance.

Residential areas surround many airports, necessitating the regulation and reduction of aircraft noise. The sources of objectionable noise in the vicinity of airports are: (1) noise associated with ground operations of aircraft, and (2) noise of flight operations.⁴ These noises can be classified further as those which can be reduced or removed by operating the airport in accordance with good modern practice

and those which inherently cannot be avoided. Reduction of all possible flight and ground noise is desirable; however, a certain amount of noise cannot be divorced from normal airport operations.

Since military jets create more noise and vibration than commercial prop or jet aircraft, locating military airports where they will be unobjectionable is more difficult than locating civilian airports.⁵ The adverse effect of military jets on land uses in the vicinity of many air bases is reflected by the large number of lawsuits for damages filed against the Federal Government during the last few years.⁶ For example, a U. S. Court of Claims commissioner in Washington, D. C., recently recommended payment of over \$200,000 to a housing subdivision for the detrimental conditions caused by B-47 jet bombers landing at or taking-off from a nearby Air Force installation.⁷

Although both propeller and jet noises are objectionable in urban areas, jet noise tends to be more objectionable because of its higher levels in the high frequency bands.⁸ Objectionable noise occurs with landings as well as take-offs. However, the take-off is more objectionable because larger amounts of power are used (assuming that the approach and climb angles are the same).⁹

The peculiar noise of the jet engine compressor has been causing some authorities on aircraft noise problems to

caution that noise suppression in the jet engine field is not entirely a matter of lowering the decibel level.* There are many other factors involved in determining physical damage produced by noise. Some of these are: individual susceptibility, intensity of sound, time of exposure, age of person subjected to sound, and the presence of any concurrent ear disorders. There seems to be no question that damage to the ear occurs from short exposure to sound intensities above 130 decibels. For this reason, recommended decibel limits by airport type at a much lower decibelage were generally considered necessary.¹⁰

The use of multi-directional runways has become more objectionable as larger, heavier, and faster aircraft have become commonplace.¹¹ With the longer and flatter glide angle necessary for many prop and all jet aircraft, land uses in the airport approach zones are affected by aircraft noise and vibration for greater distances from the end of the runway.¹² Until recently, multi-directional runways have been necessary because aircraft were not equipped to land or take-off in cross-winds. This resulted in most

*The decibel is a unit of sound; the zero decibel level being close to silence, the conversational level about seventy decibels, and the 140 decibel level actually painful to human ears.

airports having runways oriented in four or more directions, subjecting large areas in the vicinity of an airport to its operational effects.¹³

Crash Hazard of Aircraft (Real and Psychological).--The three types of crash hazards involving aircraft operations in the vicinity of airports are: (1) the potential hazard to people who live or work in the airport approach areas; (2) the potential risk to aircraft and their occupants on take-off and landing created by certain types of construction in the approach area; and (3) the hazard to navigation created by tall structures in the area surrounding the airport which would be dangerous both to people in the airplane and on the ground.¹⁴

Aircraft crashes which have caused death or injury to persons on the ground near airports have generally occurred near the center line of the runway and within the airport approach area. However, the possibility that death or injury may occur has been overemphasized in many reports, as bicycles have killed more innocent persons annually than aircraft.¹⁵

The Federal Housing Administration maintains that "the probability of physical injury to persons in or about a dwelling, or damage to buildings by an aircraft in collision is extremely remote."¹⁶ However, the fact that the psychological danger still exists is substantiated by the increase

in sales around airports of insurance providing protection against property damage caused by falling aircraft or aircraft equipment.

While aircraft landing speeds have increased from 50 to approximately 120 mph since 1925, some aviation officials predict that landing speeds will continue to increase during the next ten years. This trend has increased the possibility of aircraft crashes because higher landing speeds cause more difficulty in judging the exact point of contact with the runway. As a result, there is a greater possibility of undershooting or overrunning; and present day aircraft have less ability to fly visually under low ceiling and poor visibility with safety than the small, light, and slower aircraft of the past.¹⁷ Also, flatter aircraft glide paths and multi-directional landings and take-offs subject larger areas in the vicinity of airports to crash hazard.

The land uses in airport approach areas must be protected by means which will reduce the likelihood of property damage, injury, or death from occasional aircraft crashes. The fear of aircraft crashes by surrounding residents, whether real or psychological, will diminish if this is accomplished.

Summary of Existing Problems.--Certain land uses in the vicinity of airports have historically proved to be either structural, visibility, or communication hazards to the

efficient and safe operation of aircraft. Land uses creating such hazards as: (1) excessive structural heights; (2) gases, smoke, dust, and glare in the atmosphere around the airport; and (3) electrical interferences with radio communications between aircraft operators and airport traffic officials are those which have been regulated in the past.¹⁸

However, regulating land uses that create the above hazards only protects the airport and its operation. The surrounding land uses also require protection from airport operations. Of course, places of public assembly, schools, hospitals, churches, and high density residential developments should not be located in airport approach areas. Such incompatible land uses eventually are blighted or endangered by airport operations and, in turn, tend to blight adjoining areas.

Does an airport's presence decrease property values in its vicinity? If so, to what degree, where, and why? Upon analysis of five different studies, the following deductions are presented.¹⁹

Depending upon the specific location of dwellings in the airport approach zone, the type of aircraft using the airport, and the economic and social status of the surrounding residents, housing values are affected in the following manner. High-priced housing (\$25,000-\$50,000) will definitely have its market value depreciated, up to 80 per cent in some

cases; medium-priced housing (\$12,000-\$25,000) may or may not be depreciated depending on its location in the approach area and the intensity of use and noise level of aircraft utilizing the airport; and low-priced housing (\$8,000-\$12,000) probably will not be depreciated at all, except when airport operations are intolerable (over 120 decibels of noise).

Property values are generally not affected in areas where the owners or occupants have a definite purpose for living near the airport. If the occupants are employed by the airport or by industry located near the airport; if existing utilities and highway accessibility stimulate the development of low- and medium-priced housing; or if a housing shortage exists in the metropolitan area, housing valuations are not adversely affected.

The degree of community acceptance of aircraft operations will determine how much noise and invasion of privacy will be tolerated. This in turn will have some effect on the market value of property in the airport's vicinity.

Surrounding land uses are also adversely affected by an increase in the intensity of aircraft and automobile use and congestion at airports, as the privacy of the rapidly developing residential areas in the vicinity of airports has been invaded more and more. Where air operations were inconspicuous before with fewer take-offs and landings each

day, increased use has infringed upon the privacy of many. A corollary to this would be the effect on adjacent property owners of a lightly traveled residential street suddenly being transformed into a busy, congested major street.

Future Problems

The future promises to cast general and commercial aviation in a more favorable role if certain problems can be solved. Continued development of aviation's potential will necessitate solutions to, first, saturation of the air; and second, problems resulting from future technological developments in aviation.

Saturation of the Air.--Although saturation of the air is already becoming a problem in several scattered areas, it will become a nationwide problem in the near future unless remedial action is taken. In 1936 there were only five million take-offs and landings at airports in the United States; in 1957 there were sixty-five million, with 115 million forecast by 1975. This will necessitate a two-fold increase in the capacity of airports.²⁰ To further complicate matters, sixty million persons will be added to the existing population, forty million of which are expected to crowd into regional cities hundreds of miles long.²¹

The combination of urban and aviation growth will create more critical areas where air saturation may cause

air collisions or crashes. Unless drastic action is taken soon, the land under both airport approach and holding pattern zones will become increasingly dangerous for development. There will be an increased possibility that mid-air collisions will occur similar to the February 1, 1957, collision between a military jet and a commercial passenger plane which resulted in the latter crashing into a school yard, killing or injuring 52 children.²²

Problems Resulting from Future Technological Developments in Aviation.--Although a means of handling past and existing aeronautical developments has not been perfected, the future promises technological developments in aviation that will make past problems seem trivial.

Some aviation industry experts were asked what they expected to happen in aviation by the year 2000. Atomic power for transport aircraft and speeds up to 150,000 miles per hour were forecast. Few felt that the airplane would replace the automobile as transportation for the average individual, principally because of traffic problems.²³

However, one expert stated that vertical take-off aircraft for private use were being developed which would hold the same number of passengers as the family car, would rise and descend vertically and maintain a level flight speed of 400 to 500 miles per hour, would be simple to fly, and could be mass-produced to sell at a relatively low

price.²⁴ Such a development would revolutionize the aviation industry and increase existing difficulties for airports, and for air space and land uses in the vicinity of airports.

Undoubtedly, other unforeseen technological developments in aviation will occur which will further complicate relationships between the airport and surrounding land uses and require entirely new techniques of analysis and solution.

Summary

Difficulties between airports and land uses in their vicinity have increased with the swift spread of urbanization, the rapid development of aviation, and the likelihood of larger, faster, and noisier aircraft. Existing problems involving multi-purpose airports, airport location, noise, and crash hazards must be analyzed and techniques must be developed which will also solve future problems resulting from technological developments in aviation and from the saturation of the air. Through adequate consideration of the various problems confronting the airport and its surrounding land uses, steps can be taken to eliminate or reduce conflicts which are slowing aviation's rapid development and producing annoyance and hazard for adjoining land uses.

CHAPTER II

METHODS OF REDUCING CONFLICTS BETWEEN AIRPORTS AND THEIR SURROUNDING LAND USES

The development of a desirable land-use pattern around airports was never very seriously considered until the President's Airport Commission called attention to the need for it in 1952.²⁵ In the past, airports were located and constructed with little regard to existing or future land use in their vicinity.

Many existing airports are surrounded by densely built-up land. Since many of the land uses are not compatible with airport operations, the development of a logical and workable land-use pattern becomes more and more difficult. The most desirable land-use patterns are only possible in sparsely populated areas around new airports. Gradual transition to a desirable land use pattern would be necessary around existing airports.

As aviation has developed and become more popular, the development of several airports to handle the air traffic within a large metropolitan area has occurred. Gradually, and almost without realization, several types of airports have emerged catering to different types of air-

craft. This development has increased the necessity for securing land uses compatible with each type of airport.

Reducing Conflicts Through Adequate Airport Planning

To solve the problems of existing and future conflicts between the airport and its surrounding land uses, certain airport- and land-use development needs must be considered. These involve: (1) specialization of airports; (2) proper airport location; (3) reduction of airport operational noise; and (4) adjusting to technological developments in aviation.

Specialization of Airports

The President's Airport Commission in 1952 indicated that "it is possible that the future will call for a system of airports for a metropolitan area with separate facilities for certain types of air traffic."²⁶ The importance of such a consideration is becoming increasingly apparent because general aviation (private and business aircraft) expects a 60 per cent increase from 65,000 aircraft in 1956 to 107,875 by 1970;²⁷ commercial-passenger travel predictions indicate an acceleration from forty-two million passengers in 1956 to 118 million in 1970; and cargo ton-mileage is expected to increase from 300 million ton-miles in 1955 to 800 million by 1965.²⁸

The Cornell Aeronautical Laboratory completed a study in 1952 which considered the justification of specialized airports. The study emphasized the fact that airport specialization should not be attempted unless it is in the interest of national defense, or in an area where saturation exists (or is expected to exist) in the near future. The types of possible saturation are: (1) saturation of runway utilization at any given acceptance rate; (2) saturation of ground handling facilities, including taxiways; (3) saturation of the air space; and (4) saturation of community tolerance for annoyance or hazard.²⁹

Although airport specialization by function, performance, and average-time separation of aircraft were considered, only the first two types could be justified.³⁰ Specialization by function classifies airports as commercial-passenger, commercial-cargo, industrial, general aviation, and military:

Commercial-Passenger Airports -- Serve scheduled and non-scheduled commercial-passenger jet and prop aircraft.

Commercial-Cargo Airports -- Serve scheduled and non-scheduled commercial air-cargo operations by both jet and prop aircraft.

Industrial Airports -- Serve one- and two-engine business and light-cargo aircraft directly serving industrial areas.

General Aviation Airports -- Used exclusively by single- and two-engine private and business aircraft owned and operated by nearby residents.

Multi-Purpose Airports -- Serve areas having insufficient demand to justify specialized airports.

Military Airports -- Serve military training or defense installations.

Because of the close relationship of function and performance, specialization by performance can supplement functional specialization by classifying airports on the basis of the maximum length and angle of approach as well as the noise level of aircraft using the various types of airports.³¹

Proper Airport Location

An airport's location should be influenced by:

- (1) the types and volume of air traffic to be accommodated;
- (2) existing and proposed ground transportation facilities;
- and (3) proper distances from surrounding airports.³²

The size of an airport site will vary considerably, depending upon its function and traffic volume. The performance characteristics of the aircraft served will determine the areas where an airport can compatibly co-exist with surrounding land uses. To illustrate, airports serving only small propeller-driven aircraft can be located nearer populated areas than those handling larger, faster, and noisier

aircraft. This is possible because of the smaller site required, the airport's limited function, lower noise level, and smaller approach area affected by landings and take-offs. Military airports, because of their huge site requirements, obnoxious noise level, intensive utilization, and the large surrounding areas affected by landings and take-offs and aircraft ground testing and warmup operations, should be located beyond or on the outer fringe of metropolitan areas.

It is highly desirable and logical that airports be located adjacent to a major street, a major highway, or preferably a parkway, freeway, expressway, or some other form of limited-access highway, depending on the type of airport. This prevents the unnecessary use of local residential or collector streets for airport traffic as well as increases the airport's accessibility to its users. Airport-connector highways should be constructed to handle the type and volume of traffic which each airport type is expected to generate, as well as non-airport traffic requirements.³³

The proper spacing of airports is the best method for limiting the effect of one airport's traffic pattern on another.³⁴ Desirable distances between airports should afford exclusive air space as shown below:

Table 1. Desirable Radius of Air Space by Airport Type

Airport Type	Radius of Air Space, Miles
Military	4
Commercial-Passenger	4
Multi-Purpose	3
Commercial-Cargo	3
General Aviation	1
Industrial	1

This means that a commercial-passenger and a military airport would be eight miles apart, center to center, and a general aviation and multi-purpose airport would be separated by four miles.

In certain instances, where single or parallel runway systems are in use and the approach areas of the adjoining airports are also parallel, airports could be located one-half mile closer together without violating each other's air space reservation. For example, two general aviation airports, or a general aviation and a military airport could be located one and one-half and four and one-half miles apart, respectively.

Reduction of Airport Operational Noise

One approach to the noise problem is to lessen or eliminate noise by altering, changing, or muffling the noise

created on or near the airport premises. This can be accomplished by: (1) the use of foliage, building, and land use buffers on the airport's periphery; (2) quieting aircraft through muffling devices; (3) providing longer runways; (4) shifting gradually to the single or parallel runway system; and (5) planning or re-orienting runways to coincide with natural or compatible land use corridors whenever possible.

Various kinds of foliage have been planted on the perimeter of the Los Angeles International Airport to act as sound deadeners and to eliminate some of the sensitivity to noise by shielding the noise source from view of adjacent residents. The construction of an earth parapet, which, together with the planting of foliage, would rise 50 to 60 feet into the air is also being considered. Such a project would deflect the sound waves upward and break up and absorb the sound to some extent.³⁵

Another variation of the first method is the use of industrial and open-land uses as buffer screens between the Pensacola (Florida) Municipal Airport and the surrounding residential areas (see Figure 1, page 32). Industrial buffer areas have been utilized by the Los Angeles International Airport without complaint from adjacent residents.

The proper layout, design, and construction of airport buildings can also provide natural sound barriers between

airport operation noises and the surrounding land uses.³⁶ Although such a precaution alone would not decrease the noise level much, it would be helpful when used with other buffer screens.

The second method, which requires the muffling of extreme aircraft noise, was initiated when the New York Port Authority refused to allow aircraft (especially jets) to land at any of its airports unless the aircraft met a noise level acceptable to the public and to the Authority.³⁷ This refusal stimulated research which developed suppression devices muffling the noises emitted by the new commercial jet airliners. Jet engine testing cells also have been utilized to reduce the noise of stationary jet warm-ups to a tolerable level.³⁸

Thirdly, the availability of longer runways than the minimum required to handle the aircraft using the airport can also reduce aircraft noise.³⁹ The advantage of this is that an airplane can utilize a longer take-off run with the use of less power before becoming airborne. As a result, less noise is emitted than on a shorter runway requiring full-power take-offs.

As a fourth method, the President's Airport Commission recommended that the existing multi-directional runway systems be gradually changed to single or parallel runway systems. This change would limit the approach areas af-

fects by take-offs and landings to two as compared with four or more approach areas possible with multi-directional runway systems. With the tricycle landing gear gradually replacing tailwheel landing gear, landings and take-offs across winds in the range of 20 to 30 miles per hour can now be made, lessening the need of multi-directional runways.⁴⁰

A fifth way of reducing the effect of aircraft operational noise is to plan or re-orient airport runways so as to coincide with natural or compatible land use corridors whenever possible. Natural corridors consist of such unpopulated areas as rivers, lakes, swamps, and other similar areas unsuitable for normal land use development. The Cornell Aeronautical Laboratory indicated in 1952 that about 18 per cent of existing major airports could be improved by re-orienting the runways to utilize existing natural corridors.⁴¹ Compatible land-use corridors are those that contain noisy land uses affected very little by additional noise and that do not have structural, communications, or visibility hazards for aircraft operations. Uses within such an area could be railroad yards and tracks, warehousing, industrial areas, and other similar uses. The use of this type of corridor solves the noise problem by bringing the noise to the noise.⁴²

Adjusting to Technological Developments in Aviation

Quick and effective adjustments to the various technological developments forecast for aviation in the near future will require a great deal of planning ahead. Changes in airport requirements will, in turn, require the adjustment of neighboring land-use patterns. Some of the changes may reduce or eliminate some of the existing airport problems while other developments may create entirely new ones. However, if airports are properly planned to handle the present and foreseeable future aircraft and a compatible land-use pattern is provided in their vicinity, adjustment to future aeronautical developments should not be difficult.

Reducing Conflicts Through Proper Use of Land in the Vicinity of Airports

A desirable land-use development pattern in the vicinity of airports requires the knowledge and skillful use of these land use characteristics: (1) location, (2) density; (3) height; and (4) value.

Location

The existing and future land uses surrounding an airport are affected by the airport's existence in two distinct areas. These are, first, the approach areas extending out from the ends of runways where the brunt of airport operations are felt through the landing and take-off of

aircraft; and second, the areas adjacent to the airport not included in the approach areas, but affected either by airport ground operations or by aircraft positioning patterns prior to landing and after take-off. The length and width of the approach area will vary with the operational characteristics of aircraft using an airport and will not be considered at this time.

It has already been established that natural and compatible land-use corridors are desirable for approach areas. The President's Airport Commission indicated that schools, churches, hospitals, and other places of public assembly were not desirable land uses for the approach areas, and residences should be located at distant locations in the area as a safety precaution.⁴³

The areas adjacent to the airport but outside the approach area are not directly affected by aircraft operation, permitting a greater variety of land uses. Land uses which allow a gradual transition between the airport and surrounding residential development are desirable. Airport-allied uses as well as open-land uses, wholesaling, warehousing, industrial and commercial uses act as good buffer land uses to certain types of airports.

Density

Low-density land-use development is recommended, particularly within the inner-approach area extending out

from the end of the runway, in order to reduce the potentiality of injury or death to occupants and damage to structures in case of aircraft crashes during landings or take-offs.

Minimum residential lots of from one acre⁴⁴ up to five acres⁴⁵ have been required in approach areas. The requirement of low-density land development adjacent to the airport but outside the approach area cannot be justified by crash hazards.

Height

Keeping the height of structures and other obstructions at a level which will permit aircraft to use the approach area for normal glide path landings and take-offs is extremely important. Otherwise, both land occupants and aircraft passengers will be endangered. To cope with this situation adequately, the President's Airport Commission has recommended that a "clear zone" consisting of open land abutting dominant runways be purchased by all new airports to provide aircraft with sufficient unobstructed space to reach a safe altitude of 50 feet before encountering built-up areas.⁴⁶ Washington, D. C.'s proposed Chantilly Regional Airport has purchased the land in its approach areas extending out two miles from the airport.⁴⁷ The height of smokestacks and radio and television towers located in the vicinity of airports should also be regulated in order to protect aircraft that are positioning overhead.

Value

Within the approach area and directly adjoining the airport, residents of low-priced (\$8,000-\$12,000) housing are the least affected by airport operations, followed by medium-priced (\$12,000-\$25,000) and high-priced (\$25,000-\$50,000) housing occupants.

When low-density housing is required, however, the land value usually will require higher-priced housing. If higher priced housing were located only on the outer edges of the approach area, there would be little adverse effect on values since the devaluation of the housing is greatest near the middle and inner part of the approach area where aircraft annoyance and hazard are greatest.

Medium- and high-priced dwellings are often located adjacent to general aviation airports, whereas lower-priced housing is common around other types of airports. This is desirable as small aircraft create little annoyance or hazard to residential areas, especially when a large proportion of the surrounding residents use the airport for private and business flying.

Guiding Desirable Land Use Development in the Vicinity of Specialized Airports

Desirable land use patterns for both the approach areas and areas adjacent to airports (see Figure 1, page 32, for a desirable relationship of land uses to an airport) are recommended as follows:

Commercial-Passenger Airport

This type of airport serves scheduled and non-scheduled commercial-passenger jet and prop aircraft emitting not over 110 decibels of noise at 100 feet (equivalent to the noise level of a boiler factory as shown in Figure 2, page 33).⁴⁸ Convenient access to the business, financial, and banking centers is desirable by parkway, freeway, or some other form of limited-access highway.

Land Uses Within the Approach Area.---It is desirable that the inner-approach area be located in natural corridors utilizing rivers, lakes, swamps, areas subject to flooding, or other forms of unpopulated land. Open land uses (such as landscape nurseries and cemeteries; extensive recreational uses including golf courses, golf-driving ranges, riding academies, picnic areas, botanical gardens, and passive recreational areas; reservoirs; reservations; game preserves; forests; water-treatment and sewage-disposal plants; sod farming; truck farming and the cultivation of other vegetable and plant crops) are desirable.

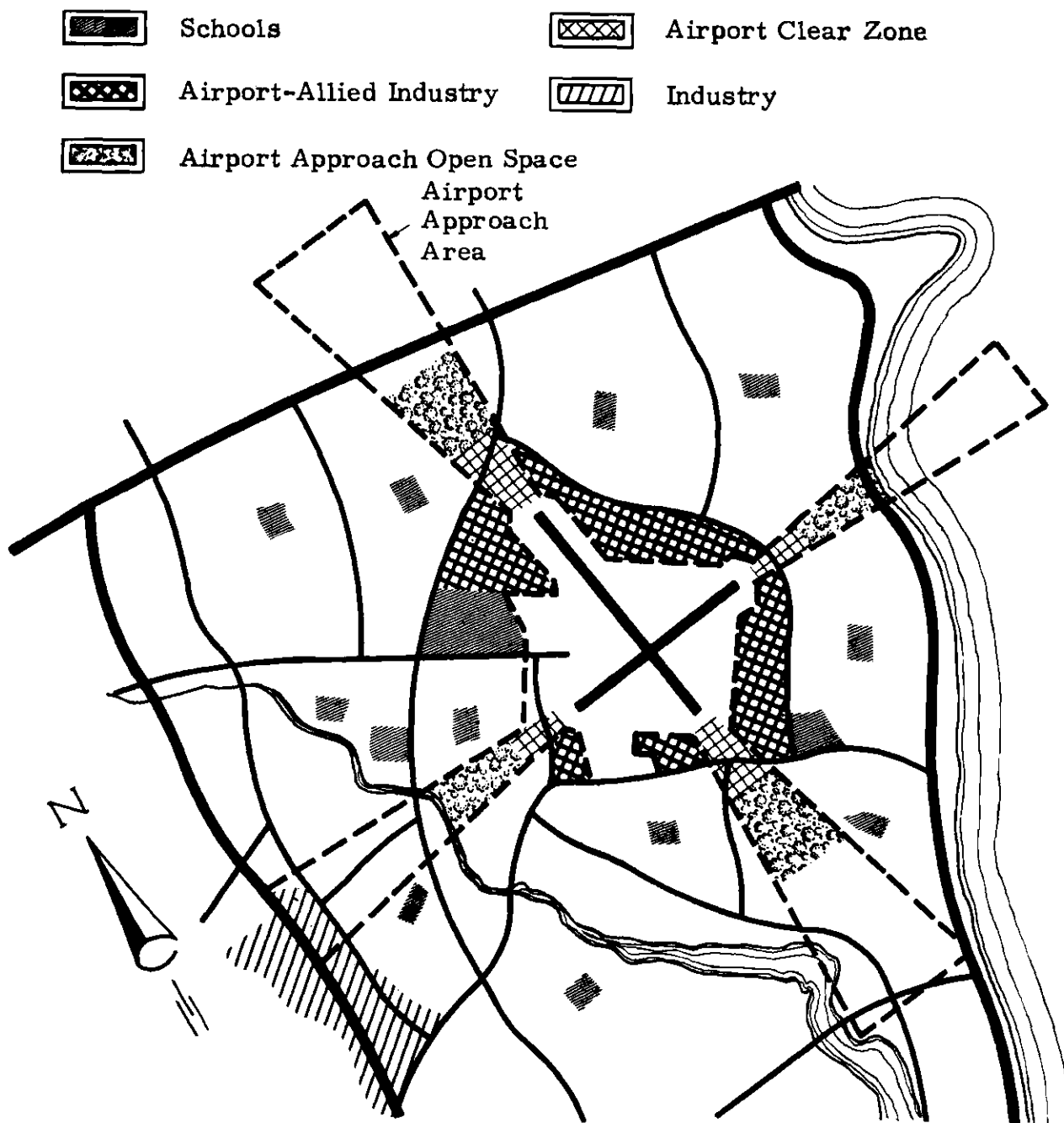
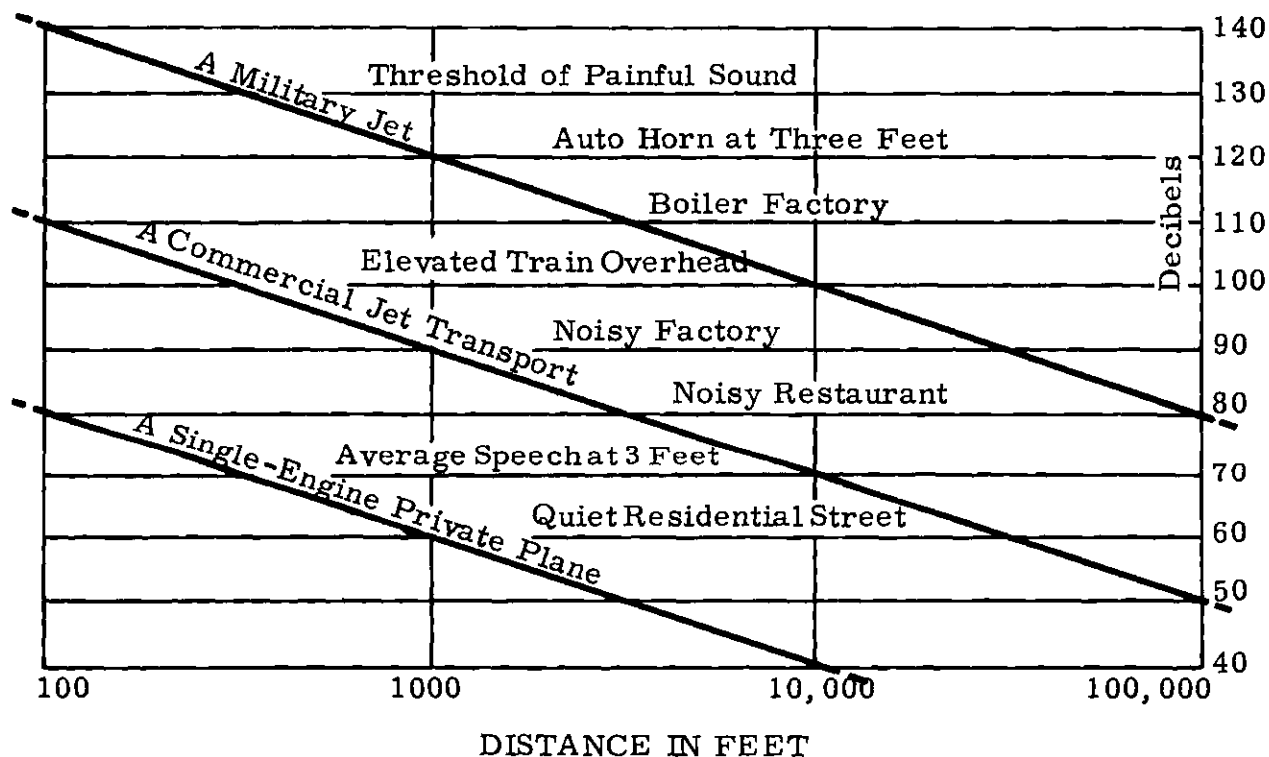


FIGURE 1 - RELATIONSHIP OF ADJACENT
LAND USE TO THE PENSACOLA MUNICIPAL
AIRPORT



NOTE: The values shown are representative rather than specific. No allowance is made for the additional benefits associated with air damping and surface losses.

SOURCE: Airports and Their Use, Report No. JA-807-B, Cornell Aeronautical Laboratory, Inc., April 7, 1952.

FIGURE 2 - APPROXIMATE SOUND LEVEL
VERSUS DISTANCE FOR THREE ASSUMED
AIRCRAFT

The outer portion of the approach area should be occupied by the above land uses or industrial, wholesale and warehousing not creating obstruction, communication, or visibility hazards to aircraft operation. Residential land uses should be located on the perimeter of the approach areas as much as possible, with their density varying from one family per acre to one family per five acres, depending on the proximity of housing to aircraft landing and take-off patterns. Low-value housing may be permitted within the outer-approach area with high-value housing occurring at a low density of development remote from concentrated landing and take-off patterns.

Schools, churches, hospitals, and other places of public assembly are undesirable in either the inner- or outer-approach areas.

Land Uses Adjacent to the Airport.--Certain transitional land uses may be used as buffers between the airport and residential land uses. Airport-allied land uses such as airline schools, aircraft repair shops, warehouses, motels, hotels, restaurants, auto-storage areas, parking lots, shopping centers, and taxi and bus terminals are excellent land-use buffers if properly located.

Low-priced residential uses (\$8,000-\$12,000) should be encouraged adjacent to the buffer area, with medium- and high-priced housing encouraged at a greater distance from

the airport. Such obstructions as radio and television towers and smokestacks should be located where they will not interfere with airport operations.

Commercial-Cargo Airport

This type of airport serves scheduled and non-scheduled air-cargo operations by both jet and prop aircraft emitting not over 110 decibels of noise at 100 feet. It should be connected by state or Federal highways of a limited-access nature which provide access to nearby wholesale, warehouse, and industrial centers.

Land Uses Within the Approach Area.--The inner-approach area should consist of a combination of natural corridor and open-land uses as described under commercial-passenger airports. Due to the airport's desirable close proximity to wholesale, warehouse, and industrial areas, clusters of these uses could be located along the fringes of the inner-approach area as long as they were of low density and did not create obstruction, communication, or visibility hazards to airport operations.

Wholesale, warehouse, and industrial land uses may also be encouraged in the outer-approach area. Any residential uses should be limited to the outer-approach area fringe and kept at as low density and low value as conditions will permit.

Schools, churches, hospitals, and other places of public assembly are undesirable in either the inner- or outer-approach areas.

Land Uses Adjacent to the Airport.--Buffer areas composed of air-freight terminals, trucking terminals, and other allied uses; aircraft and aircraft-parts manufacturers; aviation schools; aircraft-repair shops; warehouses; flying services; aerial surveys and other similar companies using aircraft for their daily work; and aviation research and testing laboratories are desirable. Other wholesale, warehouse, and industrial uses would be logical uses adjacent to the buffer area. Low-priced, then medium- and high-priced housing could then radiate from the airport.

Industrial Airport

This airport is designed to serve one- and two-engine business and light-cargo aircraft limited to 90 decibels of noise at 100 feet (equivalent to the noise level of a noisy factory). Generally located in a planned industrial district, this airport should be provided access by a form of limited-access highway connecting with railroad, truck terminals, and other adjacent industrial uses.

Land Uses Within the Approach Area.--The inner-approach area should be within the industrial-district boundaries, with its desirable land uses composed of open-park area, parking lots, railroad tracks, or low-level warehousing.

Natural or compatible land-use corridors are desirable for the outer-approach area. One-half acre and one acre residential lots would also be desirable, especially on the outer-approach area's fringes.

Schools, churches, hospitals, and other places of public assembly are undesirable in the approach areas.

Land Uses Adjacent to the Airport.--The industrial district's buildings and open space would act as the buffer area for this airport, with normal residential development adjacent to the industrial district desirable, preferably low-density housing or housing between \$8,000-\$25,000. Commercial shopping centers would also act as transitional land uses.

General Aviation Airport

Used exclusively by single- and two-engine private and business aircraft owned and operated by nearby residents, this airport (sometimes referred to as an airpark when combined with recreational uses) should be limited to aircraft generating not over 80 decibels of noise at 100 feet (equivalent to the noise level of a noisy restaurant). Major streets should serve those airports located on the edge of residential neighborhoods, with collector streets serving airports located within a neighborhood.

Land Uses Within the Approach Area.--As the general aviation airport's principal users are located in medium- and high-class residential areas, the airport should be located as

close as possible to its users without interfering with the normal neighborhood growth. Such open land uses as golf courses, botanical gardens, and passive recreation areas are desirable in combination with the airport in the approach area. Normal residential development abutting the approach area is justified. Schools, churches, hospitals, and other places of public assembly adjacent to the approach area are acceptable.

Land Uses Adjacent to the Airport.--Active recreational areas consisting of swimming pools, playgrounds, picnic areas, bridle paths, etc., are desirable transitional land uses between the airport and the adjacent residential areas. Normal densities and housing valuations could apply to surrounding residential areas outside the airport's approaches.

Multi-Purpose Airport

This type of airport should serve areas where the demand for aviation is insufficient to justify specialized airports. Commercial-passenger and cargo, as well as private and business aircraft, would be served. As jet aircraft could not economically serve these airports, the aircraft noise level should be limited to 90 decibels at 100 feet (equivalent to the noise level of a noisy factory). Accessibility to the airport should be by major streets or county, state, or Federal highways, preferably of limited access.

Land Uses Within the Approach Area.--In the quieter environment of a small city, aircraft noise would be more objectionable than in larger cities, where a certain amount of noise is considered a part of urban living. The multi-purpose airport should generally be located on the urban fringe with natural-corridor and open-land uses located in its inner- and outer-approach areas. Normal agricultural uses, including the raising of livestock, poultry, and other animals, should be allowed in the outer, but not in the inner-approach areas. Low-density residential development is desirable in the outer-approach area, especially on its fringes.

Schools, churches, hospitals, and other places of public assembly are undesirable in either the inner- or outer-approach areas.

Land Uses Adjacent to the Airport.--Open-land uses should be encouraged as much as possible. Airport-allied uses, such as aircraft and aircraft-parts manufacturers, flying services, aircraft repair shops, warehouses, motels, shopping centers, restaurants, and gas stations would also make desirable transitional land uses. When available, other industrial and commercial uses could act as buffers between the airport and normal residential development.

Military Airport

This airport is an essential part of Air Force and some Navy and Marine Corps training or defense installations. A majority of aircraft used are jets, whose noise level will often reach, but should not exceed, 140 decibels at 100 feet (equivalent to noise level painful to the human ear). As its desirable location should be away from populated urban areas on the outer fringe of metropolitan areas, a type of limited-access highway should be directly adjacent, connecting with the commercial, cultural, and residential facilities of the central city.

Land Uses Within the Approach Area.--Due to the extreme noise emitted by military jet aircraft, the inner-approach area should be devoted entirely to the natural-corridor or open-land uses recommended for the inner-approach area of commercial-passenger airports. Residential and other land uses should not be allowed in the area. The outer-approach area should utilize the same land uses recommended for the outer-approach area of commercial-passenger airports.

Land Uses Adjacent to the Airport.--Those land uses recommended for areas adjacent to commercial-cargo airports also apply to military airports.

Practical Application of Methods of Reducing Conflicts

Some of the desirable methods of reducing conflicts between airports and their surrounding land uses can be challenged as being impractical because of: (1) the degree of existing land-use development around airports; (2) the contention that economics of land development are ignored; (3) the costliness of reducing ground airport operational noise; and (4) the difficulty of applying fair and impartial standards to all situations.

However, it cannot be over-emphasized that while these desirable standards will not be completely achieved in many cases, the gradual adjustment and refinement of the existing land-use pattern to a more desirable one is the ultimate goal. Since a wide range of compatible land uses is available, the requirement of a desirable pattern of development need not be unpopular, as illustrated by the enthusiastic endorsement of the proposed land-use pattern around the Pensacola (Florida) Municipal Airport. Surrounding land owners, after understanding the purpose of the program and being shown how a fair return on their investment could be achieved, backed the program. The elimination of costly litigation and the increased prospect of maximum airport operational efficiency should offset the initial expense of adequately buffering airport ground operational

noise. Finally, there are proper legal tools for fairly and judiciously carrying out these desirable standards of guiding airport and surrounding land-use development.

Summary

The formulation of a desirable land-use pattern around airports can be accomplished only after considering the problems confronting airports and land uses in their vicinity, and analyzing airport and land-use development factors. As a result, the majority of the conflicts between airports and their surrounding land uses can eventually be reduced or resolved through: (1) adequate airport planning, (2) proper use of land in the vicinity of airports, and (3) guiding desirable land-use development in the vicinity of specialized airports.

CHAPTER III

LEGAL DEVICES FOR THE CONTROL AND PROTECTION OF LAND USES IN THE VICINITY OF AIRPORTS

The effective use of legal devices to safeguard the "public good" is important in private, commercial, and military aviation. The legislatures and courts are confronted with the problem of how to resolve conflicting property rights of airport owners and surrounding land owners, and with the problem of determining to what degree private property rights should be restricted in order to protect the public interests in airports.

The conflicts between nearby residents and airport operators are becoming more numerous as urbanized areas expand and air activity increases. Public officials are being forced increasingly to give more attention to the resolution and adjudication of these conflicts. They must have answers to such questions as: (1) what legal devices are available to be used in dealing with airport problems; and (2) what new legal devices will be needed to meet problems posed by the greatly expanded scope of aviation in urban life.

Proper airport planning, as a part of the future land-use plan, can reduce or eliminate future conflicts

between airports and their surrounding land uses. Such police power legal tools as zoning and subdivision regulations can regulate or guide proper development around airports. These police power tools can be supplemented by adjacent land acquisition procedures allowed through eminent domain. However, more clearly defined legislation is needed on the state and Federal level to make the above legal tools more effective.

The Future Land-Use Plan

The future land-use plan is the guiding outline for long-range urban growth and development against which the planning commission, in making its recommendations to the governing body, can judge and evaluate current urban demands and requirements. It shows how existing and proposed residential, commercial, industrial, and public land uses should be related to each other. Airports, along with other transportation facilities, are included in the future land-use plan.

Urban land-use plans which are limited by municipal boundaries are rapidly losing their effectiveness because the critical areas of urban growth needing planning tend to sprawl over several municipalities and unincorporated areas. This situation indicates that planning on a metropolitan or regional basis is needed to guide and control land-use development.

As one element of the future land-use plan, airports have been planned with little regard for other inter-related phases of urban planning. Proper airport planning can be best achieved through the coordination of a plan for the location of airports with a metropolitan or regional land-use and major-street plan.

Metropolitan or Regional Plan for the Location of Airports

To provide the necessary background for a metropolitan or regional study of the location of airports, an aviation economic potential study should be prepared. This study would estimate the future demand for commercial-passenger and cargo traffic, the location and demand for private aircraft, and future airport space requirements.⁴⁹ The results of this study should guide the location of future airports in undeveloped areas.

The metropolitan or regional plan for airports would indicate the general location, number, type, and size of airports. However, airports are not well located just because an adequate number of the right type and size are properly spaced in the area involved. They also should be accessible to the areas they serve and compatible with their surrounding land uses.

To avoid compounding the difficulties between airports and surrounding land uses, two steps are necessary. First, airports must be planned as a part of the overall metro-

politan or regional future land-use plan. Second, the required airport sites must be purchased or reserved prior to development of the area, reducing acquisition costs and land-assembly problems.

As a part of the land-use plan, airports should be located reasonably near or accessible to their users. The major-street plan can guide airport development to areas adjacent to existing or future major streets or highways. Airports should be located in areas where surrounding land uses will not conflict with airport operations. This would prevent the blighting of surrounding land uses, reduce annoyance and hazard to the residents, and prevent the restrictions of the airport traffic capacity.

Airport Site Plan

An individual airport site plan is the detailed layout of the airport. An excellent airport site layout will not only increase efficiency of airport operations but also help reduce or eliminate conflicts with surrounding land uses. An airport site plan can limit future conflict through reduction of ground operational noise by: (1) the provision of a site of adequate size and shape to allow the planning of sufficient open space between the end of runways and the airport boundary; (2) orientation of runways to utilize natural and compatible land-use corridors in its approach areas; (3) use of airport buildings as noise buffers; and

(4) use of existing and transplanted foliage as a buffer screen on the airport's perimeter.

Devices Utilizing the Police Power

There are several interpretations of the difference between police power and the power of eminent domain. Parker and Worthington's definition, however, seems the clearest cut:⁵⁰

Under the police power, the public welfare is promoted by regulating and restricting the use and enjoyment of property by the owner. Under eminent domain, the public welfare is promoted, by taking the property from the owner and appropriating it to some particular use . . . A man cannot be compelled, under the police power, to devote his property to any particular use, however advantageous to himself or beneficial to the public; but he may be compelled to refrain from any use . . . In regulating or restricting the uses of private property, there is, in fact, no appropriation of it whatsoever. He may suffer some injury, in that he is disturbed in the enjoyment of his rights, but for this he is compensated, in the theory of the law, by sharing in the general benefits which the regulations are intended and calculated to secure.

A clear understanding of the police power as compared with the power of eminent domain is necessary to determine where zoning and subdivision regulations can be used as police power tools in the vicinity of airports and where some form of acquisition under the power of eminent domain should be undertaken.

Zoning

Airport approaches have been regulated by separate airport zoning ordinances as well as by city-wide zoning

ordinances. In the past, airport zoning has been concerned with the regulation of the land surrounding an airport to prevent the creation of physical hazards and obstructions in the approaches to the airport. Its purposes were to protect the airport approaches from obstructions and hazard, as well as the lives and property of the flying public and residents in the vicinity of the airport. This meant that airport zoning was for the public health and safety as well as for the community benefit and general welfare.

Evolution of Airport Zoning Controls.--The initial ordinance regulating and controlling land uses in the vicinity of airports was the Alameda County (California) Airport Zoning Ordinance, which was adopted in December, 1928. This ordinance prohibited obstructions over a height of 50 feet within 1,000 feet of any airport in the county.⁵¹ Control of structural height limitations in airport approach, transition, turning, and landing zones.

Hazard marking and lighting, the prohibition or control of land uses creating obstruction, visibility and communications hazards to aircraft operation, and spacing of adjacent airports have been added since 1940.

As an outgrowth of a sequence of tragic accidents resulting from aircraft crashing in heavily populated approach areas near the Newark, New Jersey, Airport, the control of land uses and their densities in airport approach

areas was advocated by the President's Airport Commission in 1952. Thus, airport zoning theory has evolved from a simple height restriction to a complex system of land-use control.

Validity of Airport Zoning.--Only a few court cases have tested the validity of airport zoning. In Mutual Chemical v. Baltimore,⁵² the court held height regulations prohibiting the erection of buildings higher than five feet within 100 feet of an airport confiscatory. But this regulation was so strict and limited in scope as not to be a true test of good airport zoning.

A second case, Yara Engineering Corp. v. City of Newark, et al,⁵³ involved an ordinance restricting the height of structures within two miles of Newark Airport. It was held invalid because adequate state enabling legislation did not exist. The court also stated that the city was attempting to accomplish by zoning something that should have been accomplished by purchase or condemnation. Again, this case declared the ordinance invalid because of lack of state enabling legislation, not because of any height restrictions involved in airport zoning. However, the case did lend support to the contention that certain land adjoining airports should be purchased, not zoned.

A third case, United States v. 357.25 Acres of Land⁵⁴ indirectly upheld the validity of airport zoning. A United

States District Court rendered a verdict in favor of a zoning ordinance which prohibited buildings greater than 25 feet in height from being constructed within a given distance from a military airport. The Court further indicated that it did not believe that the involved property had suffered any great depreciation in value through this restriction of building height.

Finally, in Burnham v. Beverly Airways, Inc.,⁵⁵ the Supreme Judicial Court of Massachusetts clearly recognized the police power as an adequate legal basis for airport zoning in deciding in favor of an owner of a private airport over adjacent residents who indicated interference with their property from low flights.

The above cases indicate that airport zoning is valid if adequate state enabling legislation exists, and if the particular airport zoning regulations are not so restrictive or limited in scope as to be unreasonable. The drafting of airport zoning regulations which will be upheld in the courts must balance two conflicting interests. One interest must take into consideration the airport's value to the municipality and the general public, its adequacy for safe aircraft operations, and the adverse effect of the property, if not regulated, on airport operations. The other interest is concerned with the landowner's property rights, including

consideration of the existing and possible uses of the property, the extent the use is limited by the regulation, and the injury resulting.

The Integration of Airport Zoning with Comprehensive Zoning.--

With the combination of airport zoning and comprehensive zoning in one zoning ordinance, certain advantages can be realized.

Comprehensive zoning is achieved after a future land-use plan is completed for the urban area. The zoning map should reflect the land uses shown in the future land-use plan. Airport zoning was able to function alone in the past because generally only height regulation was involved in the approach areas which were smaller than those used now. But today, with the development of larger, faster, noisier, and more hazardous aircraft in greater numbers, airport zoning should become a part of comprehensive zoning.

By becoming a part of the comprehensive zoning ordinance, zoning of airports and their approaches can be achieved through adequate study and coordination with other important urban planning phases affecting airports. Because so many airports are now located in metropolitan areas or regions, the zoning of airport approaches can be more efficiently handled in one ordinance. This is due to the fact that only one ordinance would be in force, facilitating and simplifying the adoption and administration of regu-

lations and allowing quicker adjustment when technological developments in aviation dictate that changes should be made. It should also assure validity since, as a part of a comprehensive zoning ordinance, the regulations are more likely to pass the test of reasonableness.

Zoning in advance of the actual location of an airport could limit the development of land uses in the vicinity of the airport to those uses harmonious with future airport operations. As a result, hazards would not have to be eliminated subsequently; expansion of the airport site beyond ordinary operational requirements to include clear zones would not be necessary; and depreciation of surrounding property would be minimized.

Zoning for Airports in Metropolitan Areas or Regions.--The major disadvantage of combining airport zoning with comprehensive zoning is that a large percentage of airports and their surrounding approach areas are outside municipal boundaries or within two or more counties and might not be controlled or protected by this integration of ordinances. Zoning and urban planning by all units of government are needed. Airport studies are not effective unless conducted on a metropolitan area or regional scale with each airport protected by comprehensive zoning. Unless adequate land-use and major street development are guided through urban planning and zoning, the areas surrounding airports will develop haphazardly and adversely influence airport operations.

When airports and their approach areas are outside municipal jurisdiction, it may be necessary for airport zoning ordinances to remain separate from comprehensive zoning ordinances until city or county planning and zoning are authorized and put into effect in that particular area. When both airports and their approach areas are within zoned jurisdictions, comprehensive zoning ordinances should cover zoning of airports as well as other land usage.

Subdivision Regulations

Subdivision regulations guide the location and design of streets, lots, and utilities. These regulations can assist in the development of desirable subdivisions in the vicinity of airports.

The reservation of school, park, and other public sites can be guided by the planning commission through subdivision plat approval in accordance with the future land-use plan. Residential densities can be controlled through minimum lot size, lot dimension, and setback standards specified in the subdivision regulations. In those areas having no zoning ordinance to control density, this may be the only control of density. Where public utilities are non-existent, low density lot sizes can be required to meet minimum health department standards.

The location and design of street rights-of-way to best utilize the topography, natural buffer areas, and other

similar natural assets can also lessen the annoyance and hazard created by airport operations.

By requiring compliance with subdivision regulation restrictions which prohibit the development of land which is unsuitable for subdivision (flood plain, extreme slopes, etc.), natural corridors can be preserved for use as aircraft approach areas. The reservation of land for such community facilities as public golf courses, reservoirs, regional parks, and other public open-land uses recommended in the future land-use plan can also be effected through land subdivision regulation. Street rights-of-way, bluffs, and existing foliage can be utilized as a screen between residential development and the adjacent airport or its inner-approach zone. Although some land abutting the airport would be lost for subdividing purposes, the value of the remaining land would be enhanced by less noise and greater safety for subdivision residents. This unused land might be purchased by the airport operators to protect their investment in the future.

Devices Utilizing the Power of Eminent Domain

Eminent domain involves the taking of property for a public purpose and requires compensation. The regulation of structural heights and land uses located in airport approach areas through airport zoning (police power) has been questioned. Does such regulation constitute a taking of

property and require compensation? If so, under what conditions?

The theory that the land owner owns only so much of the air space as he actually occupies is one of five air-space theories used by the courts to decide damage suits involving low aircraft flights over developed areas.⁵⁶ This theory seems to be the most reasonable of the five because it stresses the following three points: (1) air space cannot be owned by the land owner; (2) all the land owner is entitled to is protection against actual damage; and (3) an aviator should not be prosecuted unless he does actual damage or persists in low flights which have a cumulative damaging effect on the property owner.

The courts have found invalid airport zoning which prohibited the erection of buildings higher than five feet within 100 feet of an airport's boundaries. Building height restrictions of 35 to 50 feet are usually termed reasonable because they would allow a person to use his land for residential and other similar purposes. Such restrictions are not considered a taking of property under the theory that the land owner owns only so much of the air space as he actually occupies.

To achieve complete protection of an airport's approaches, it is usually necessary to supplement airport zoning (police power) by either acquiring land in fee,

land developmental rights, or avigation easements (air rights above a certain altitude) under eminent domain.

Land Acquisition

Outright land acquisition in fee combined with airport zoning has been advocated by the Civil Aeronautics Administration as the best method of protecting airport approaches. When the necessary land has been condemned or purchased, aircraft will have the benefit of a cleared area extending out from the end of runways over which to reach a safe altitude of 50 feet before encountering adjoining land-use developments. These lands may be leased for agricultural uses and other open-land uses which will not affect or be affected by aircraft operations.

Although land acquisition is the most expensive method, it is the safest and best to use when the desired land near the end of the runways is already developed. The purchase of sufficient land at the end of runways (i.e., enough to allow aircraft to reach an altitude of 50 feet before encountering land-use development) should be accomplished for heavily used airports serving aircraft emitting 110 decibels or more of noise.

Purchase of Land Development Rights

This method is the least expensive of the three eminent domain methods and is especially appropriate when

open land is available near the end of airport runways. It is recommended by the Civil Aeronautics Administration as the best alternate to outright purchase. It involves the purchase of easements which will give sufficient control over the land to prevent the erection of any future structures other than those involving aids to air navigation. In this way the developmental rights of existing agricultural land or other similar open-land uses could be purchased to insure the land's remaining in agricultural use.

This method should be used around all new airports and airport sites before the land is developed with other uses. Generally it is the preferable method of purchase because: (1) it is the least expensive; (2) it is the easiest to apply; (3) it generally permits continuation of existing land uses; and (4) it is the most flexible because the rights can be sold back to the owner if technological advances in aviation indicate that developmental rights are no longer needed for protection from annoyance and hazard.

Purchase of Avigation Easements

Avigation easements are aerial rights-of-way above a certain altitude over private property in airport approach areas which structures and other obstructions cannot legally penetrate. These air rights are purchased from the property owner as an airport protective device. An avigation easement

is the least desirable of the three eminent domain methods as it protects only the airport operator and not the adjoining residents. To illustrate, air rights of property within approach areas could be purchased so as to limit the height of development to an altitude of 25 feet above that of the runway, allowing the airport operator to remove any obstructions extending above that altitude. The land owners would be able to use their property below that altitude for most normal uses. However, it would allow the density of land development to increase as long as airport air rights were not obstructed in any way. The likelihood of residential blight would still exist because of the aircraft noise and hazard, resulting in the land-use conflict still not being satisfactorily resolved.

This method is almost as costly as outright purchase as it is almost impossible to determine the value of such an easement accurately. The value of the avigation easement is difficult to establish because it involves a determination of the difference between the value of the land before the grant of the easement and the value afterwards.

The purchase of avigation easements should be attempted only in cases where land purchase or land developmental rights purchase is impossible.

State Legislation Concerned with Airports

Better state legislation is needed to control and protect the development of airports and their surrounding land uses through urban planning, the police power, and eminent domain. State legislative assistance can be utilized through more clearly defined state enabling legislation for airport zoning, state planning, and metropolitan-regional planning and zoning.

Airport Zoning Enabling Legislation

Although at least 41 states and two territories have adopted airport zoning enabling legislation patterned after the CAA-NIMLO Model Act (co-sponsored by the Civil Aeronautics Administration and the National Institute of Municipal Law Officers), this legislation is too weak and out-of-date to handle many of the existing problems. The act is concerned mainly with the control of structural and natural growth heights in approach zones and navigational, electrical, and visibility aircraft hazards. There is a definite lack of protective provisions for the surrounding land uses.

Existing airport zoning enabling legislation should be revised and be incorporated into general zoning enabling acts so as to enable local governments to control the land uses surrounding airports more effectively. State airport zoning enabling acts, in the past, have concentrated

exclusively on protecting the airport, resulting in a very narrow and one-sided approach to the problem of the airport and its environs.

The following changes and adjustments should be made in airport zoning enabling legislation to permit local governments to adopt zoning ordinances capable of reducing the number of conflicts occurring in the vicinity of airports. Local governments should be authorized through zoning:

- (1) to control land-use development in the vicinity of all airports, not just those operated in the public interest;
- (2) to require the use of buildings and foliage buffer screens to reduce airport noise;
- (3) to require the orientation of runways and approach areas so as to use natural and compatible land use corridors;
- (4) to limit aircraft to those whose noise levels are compatible with existing and proposed land uses;
- (5) to require adequate separation from adjoining airports;
- (6) to control land-use types, their location, density, and height in airport approach areas; and
- (7) to combine airport zoning as an integral part of the comprehensive zoning ordinance.

The state should be given the power to zone airports and their approaches in extreme cases when local governments through ignorance, inability, or lack of desire, fail to take advantage of their power to establish proper airport zoning.

Legislation Authorizing Metropolitan-Regional Planning and Zoning

Planning and zoning for an entire metropolitan area are becoming more popular. Joint city-county planning and zoning is a form of planning on a metropolitan area basis. However, its effectiveness is reduced when urban development extends outside the county unless all counties and cities within a metropolitan area participate. Also, if a great many municipalities and unincorporated areas are involved, metropolitan area planning and zoning becomes increasingly difficult to achieve at the local level. State legislation is needed to lessen this difficulty.

Legislation Authorizing State Planning

Where state planning commissions have been authorized and established, comprehensive studies are made of the existing conditions and probable future growth of the state. The coordination and development of airports and airways on a state-wide basis should be an important part of such a program. Those states not having a state planning program should initiate one as soon as possible.

Federal Legislation Concerned with Airports

The Federal Government (which has the power to regulate airports through the exercise of its commerce, war, and postal powers) has indirectly guided the formulation of

various regulatory laws by state and local governments. These laws are being used to protect and control land uses in the vicinity of airports. The Civil Aeronautics Administration (CAA) formulated the Model Airport Zoning Act and Ordinance. The CAA also is responsible for administering the Federal Airport Act of 1946.

Model Airport Zoning Act and Ordinance

The Model State Airport Zoning Act (revised for the fifth time November 7, 1944, by the Civil Aeronautics Administration in cooperation with the National Institute of Municipal Law Officers) was instrumental in guiding the regulation and protection of airports by state and local governments. A companion Model Airport Zoning Ordinance, revised in September, 1945, also has been used extensively as a guide for local airport zoning ordinances.

A comprehensive revision of both the Model State Airport Zoning Act and the Ordinance are needed to insure the protection and control of airports and of land uses surrounding airports. The seven changes recommended for airport zoning enabling legislation should be incorporated into the Model Act and Ordinance. The Model Act and Ordinance would then be able to guide the development of airports and the land uses in their vicinity more effectively.

Airport Act of 1946

The Federal Airport Act of 1946 and its accompanying Federal Aid Airport Program have helped immeasurably in controlling future airport locations as well as determining whether existing sites should be improved through Federal aid. The Act specifies that airport approach areas shall be adequately cleared and protected by removing, lowering, relocating, marking, or lighting existing airport hazards and it prohibits the creation of future airport hazards.⁵⁷

The basic objective of the Federal Aid Airport Program is the establishment of a nation-wide system of public airports adequate to meet the present and future needs of civil aviation. The Act helps to control future airport locations by requiring local governmental bodies requesting aid to prove that: (1) the location of the proposed airport meets the requirements of the current National Airport Plan; (2) the airport will be suitably maintained and operated; and (3) approach areas will be adequately cleared.

The administrator of the Act (the CAA) is concerned with the safety of airport operations, traffic control, and whether airport operations should be continued at the existing location or moved to a better location. Through the Airport Act and Federal aid, the Federal Government can very effectively guide the development of future airports throughout the United States.

When combined with a locality's urban planning program, the granting or withholding of financial aid under the provisions of the Airport Act of 1946 is of tremendous importance to the proper development and location of existing or future airports. Federal matching funds are available to purchase land, developmental rights, or aviation easements adjacent to the end of dominant runways in order to reduce the conflict between aircraft and adjoining land uses.

Summary

To guide and control the desirable development of airports and the land uses in their vicinity, local, state, and Federal governments should utilize a variety of planning and legal devices. The future land-use plan is the basic tool for guiding land-use development and encouraging a desirable relationship between airports and their surrounding land uses. With the assistance of this plan, a metropolitan or regional plan for airports and individual airport site plans can be formulated.

Zoning ordinances and subdivision regulations are police power legal tools needed to control existing and future land-use development around airports. The inclusion of airport zoning as an integral part of comprehensive zoning permits the control of land uses adjacent to airports as well as those within the approach areas. Zoning on a

county, metropolitan, or regional scale is necessary to serve airports located outside municipal boundaries. Subdivision regulations guide future land-use development in the vicinity of airports through proper requirements for street layout, residential density control, and reservations for community facilities.

The power of eminent domain should be judiciously used to purchase affected property, its development rights, or aviation easements over the land when airport zoning would deprive the owner of its use for residential or other similar purposes.

State enabling legislation should be broadened and improved to permit local governments to adopt zoning ordinances capable of reducing the number of conflicts occurring in the vicinity of airports. Legislation authorizing planning and zoning in some form throughout metropolitan areas and regions should be utilized to draw the municipalities and unincorporated areas of a metropolitan area or region into one overall plan of development and regulation. State planning commissions should be created to coordinate and develop airport planning on the state level.

At the Federal level, the Model Airport Zoning Act and Ordinance should be modernized and broadened in scope and effective use made of the financial assistance provisions of the Airport Act of 1946, to guide the location and development of new airports.

CHAPTER IV

A TECHNIQUE FOR PROVIDING MORE ADEQUATE LAND-USE CONTROL IN AIRPORT APPROACH AREAS

Airport approach areas or zones recommended by the President's Airport Commission in 1952 are now in use on a nation-wide basis. These approach areas are very inflexible for two reasons: (1) the same shape and size of approaches are used without variance for all airports, regardless of the type of aircraft involved; and (2) changes in aircraft operational capabilities do not allow for adjustment of these approach area boundaries.

The Commission has recommended that a clear zone, completely free of housing or other types of obstructions and preferably owned by the airport, extend at least one-half mile from the end of runways, 1,000 feet wide at its inner and outer ends. It was further advocated that this zone become fan-shaped for the next two miles, with a width of 6,000 feet at the outer end (See Figure 1, Chapter II, page 32). The Commission has recommended that the entire area contain no schools, hospitals, churches, or other places of public assembly. Land use should be restricted to agriculture as much as possible, with housing confined to the portions of the area most distant from the end of the runway.

Also, buildings tall enough to constitute flight path obstructions should not be allowed.

The Federal Housing Administration (which insures approximately one-fourth of the mortgages on new non-farm dwellings in the United States) does not consider these approach zones flexible enough for purposes of mortgage insurance. It claims:

"It is not practicable to attempt by mathematical formula to rate precisely the risks inherent in all situations. Neither is it proper to draw lines around each installation [airport] and take the position that locations at a given distance are invariably ineligible, while other sites a few feet farther removed are acceptable."⁵⁸

An attempt will be made in this chapter to improve on the existing airport approach area provisions.

Noise Intensity and Crash Hazard

To accomplish this objective, techniques for determining the desirable length, width, and shape of airport approach areas for various types of airports will now be considered.

As aircraft noise intensity and crash hazard are the fundamental problems confronting airports and their surrounding land uses, research was concentrated on those two factors. Techniques developed by Roy Wenzlick and Company (1953) were utilized in measuring aircraft noise intensity. Crash hazard was measured through the use of techniques developed by the Cornell Aeronautical Laboratory (1952).

Aircraft Noise Measurement Technique

In 1953, Roy Wenzlick and Company, Real Estate Economists, Appraisers, and Counselors, made an appraisal of damage to real estate that would probably result from the establishment of Detroit's proposed Northeast Airport.⁵⁹ They measured the noise intensity of one- and two-engine light aircraft, four-engine propeller-driven passenger aircraft, military jets, and the then-new four-engine commercial-passenger jet aircraft, as well as the effect of this noise intensity on surrounding residential areas.

At that time commercial-passenger jets did not have the noise suppression devices they have today. Only after the New York Port Authority prohibited the use of its air terminals by commercial-passenger jets were adequate noise suppression devices developed. The French Caravelle Jet Airliner was the first plane to utilize this development, followed by the English Comet and the Boeing 707. Noise intensity studies of the Caravelle⁶⁰ and Comet⁶¹ aircraft for the New York Port Authority by Bolt Beranek and Newman, Inc., Acoustical Engineers, indicated that their flight characteristics were such as to make it possible for them to operate at external sound levels no greater than those of such large conventional propeller-driven aircraft as the DC-6 and the Super Constellation.

As a result of the reduction of the noise intensity level of the commercial jet through noise suppression

devices, Wenzlick's findings on the noise intensity of conventional four-engine propeller-driven aircraft can also be applied to commercial jet aircraft.

Figure 3 illustrates the aircraft noise intensity of four-engine commercial jet and propeller aircraft at certain distances and elevations from the end of the airport runway. The Wenzlick studies found that residential building sites near the end of runways where there was a noise intensity of 90 decibels or more suffered a significant decrease in value. As the decibelage increased from 90 decibels (the noise level of a noisy factory) up to 140 decibels, a still greater decrease occurred in residential land values. With noise intensities of less than 90 decibels, decreases in residential land values were insignificant.

The area receiving noise intensities of 90 decibels or more is shown in Figure 3. This area extends out 2.1 miles from the runway end and includes the one-half-mile-long clear zone recommended by the Civil Aeronautics Authority. Since commercial passenger aircraft take off with a minimum glide angle of 40:1 (forty feet horizontally for every foot vertically), aircraft would be flying at approximately 130 feet altitude one mile out and at 275 feet at 2.1 miles (that point where the decibelage becomes less than 90).

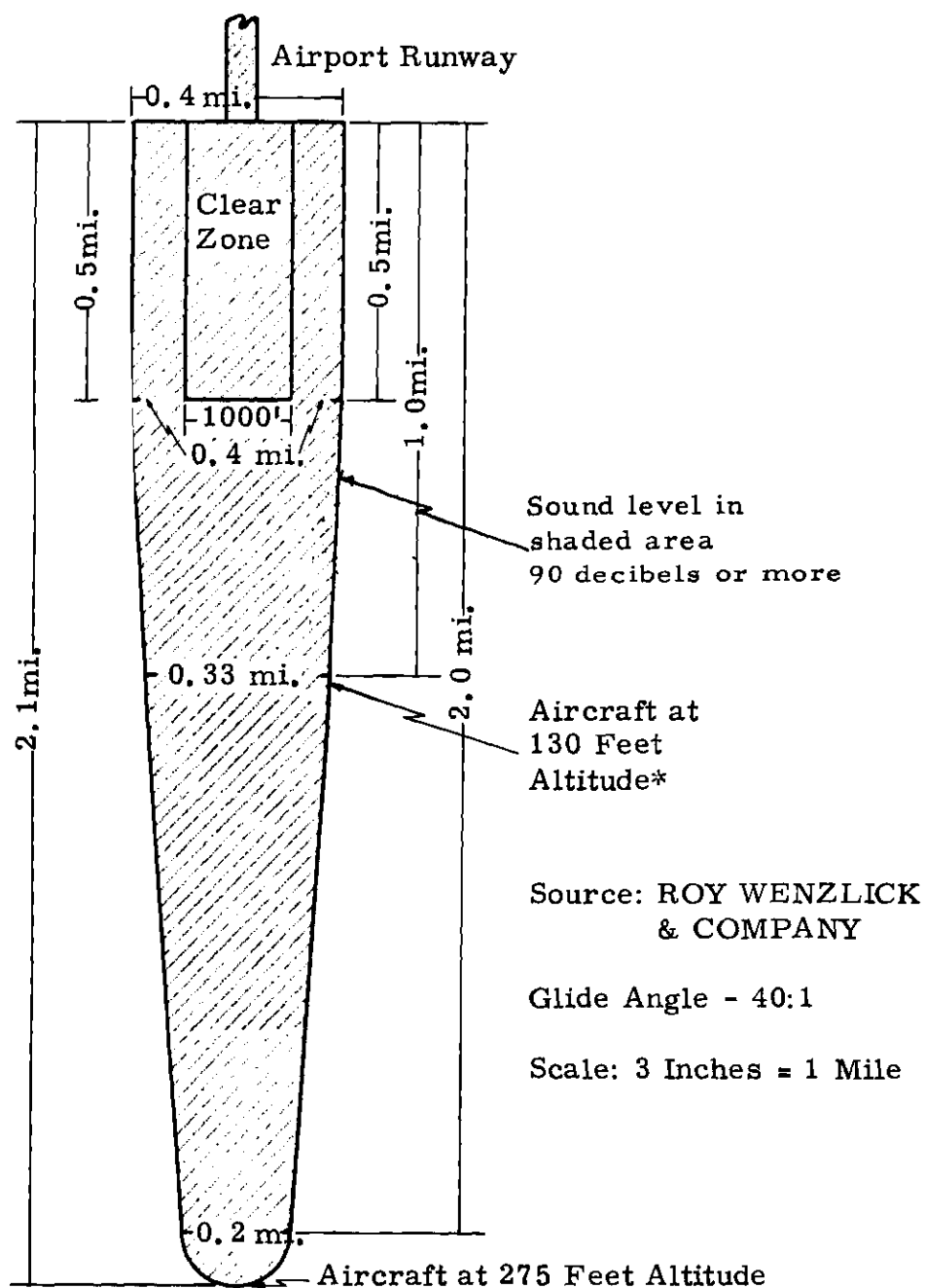


FIGURE 3 - AIRCRAFT NOISE INTENSITY,
FOUR-ENGINE COMMERCIAL JET AND
PROPELLER AIRCRAFT

* Altitude based on
altitude at end of
runway

Aircraft Crash Hazard Measurement Techniques

In 1952, the Cornell Aeronautical Laboratory was assigned the task of preparing a working paper for the President's Airport Commission on how to alleviate certain problems inherent in the present location and use of airports. Among their findings was a technique of estimating, for various types of aircraft, the crash hazard to the population in the vicinity of airports.⁶² Aeronautical engineers developed a crash hazard damage potential technique and assigned crash hazard index numbers. To test their reliability, they were compared with the ratings of an experienced airline pilot and were found to be remarkably similar.

This technique involved the assignment of a crash hazard index to specific areas around the airport. The crash hazard index assigned indicates the relative chance of a spot on the ground in the specific hazard area being hit (see Figure 4) and the potential damaging energy of the airplane when it hits. The crash hazard index is not based on the number of crashes on take-off per year in a specific area, but rather on aircraft performance and operational characteristics at specific points of landing or take-off, what a pilot is likely to do in case of a stall, loss of control, structural failure, explosion, rough air, etc. In short, it is based on crash hazard probability and not on crash hazard history.

Assignment of Crash Hazard Zones.---Figure 4 shows the aircraft crash hazard pattern for four-engine commercial jet and propeller aircraft. The landing and take-off crash hazard patterns are considerably different in orientation, size, and shape. This is because take-offs are from a fixed runway under full throttle, narrowing the area of crash hazard damage potential. Larger areas are potentially affected during aircraft landings (particularly near the end of the runway) because of the possibility of stalls, of under- or over-estimating the elevation of the airplane to the runway, or of coming in for a landing at an angle to the runway. The crash hazard pattern for landings under instrument (IFR) conditions is shown in Figure 4 in dashed lines.

Tables 2 and 3 list each specific crash hazard area by letter and crash hazard for each of three types of aircraft. A description of how these areas were determined is also given. Location of these potential crash hazard damage areas is shown in Figures 4, 5, and 6.

The only area not covered in the tables is the circular traffic pattern which is utilized by all aircraft in positioning before approach and after take-off. This area was not considered for land-use planning or zoning purposes (except for obstructions) because the damage potential is considerably less than that for areas in line with the runway.

Table 2. Bases for Delineating Boundaries of Crash Hazard Areas
for Aircraft Approaches (See Figures 4, 5, and 6)

Area	Aircraft Performance and Operational Characteristics	Twin- Engine Aircraft	Four-Engine Commercial and Jet Aircraft	Military Jet Aircraft
<u>Area A</u>	<p>1) In case of complete power failure, the pilot can make up to a 45 degree turn to select the safest spot to land the aircraft in this area. The crash location will depend on the aircraft glide path and altitude, and the distance from the runway.</p> <p>2) Stalls, loss of control, structural failure, explosion, etc., will also cause an aircraft to crash in this area.</p>	<u>50 Crash Hazard</u>	<u>25 Crash Hazard</u> (Chance of complete power failure is less but potential damage is greater than for twin-engine aircraft. Aircraft are heavier and carry more fuel, making a crash more damaging.)	<u>100 Crash Hazard</u> (Greater chance of a flameout or explosion, plus greater damage potential than for commercial aircraft.)
<u>Area B</u>	Aircraft are less apt to land in this area in case of partial power failure because normal aircraft approach glide paths are at least one mile away. If forced to land in this area, pilot could select the safest spot.	<u>25 Crash Hazard</u>	<u>12 Crash Hazard</u> (Less chance of partial power failure and stalls because of the number of engines and aircraft speed. Greater potential damage than twin-engine aircraft)	<u>20 Crash Hazard</u> (Chance of partial power failure slight but greater potential damage because of speed, weight, etc.)

Table 2. Bases for Delineating Boundaries of Crash Hazard Areas
for Aircraft Approaches (See Figures 4, 5, and 6) (Continued)

Area	Aircraft Performance and Operational Characteristics	Twin- Engine Aircraft	Four-Engine Commercial and Jet Aircraft	Military Jet Aircraft
<u>Area C</u>	Aircraft crash potential in this area is greater as a result of power failure or stalls because aircraft are approaching the runway at a low altitude and speed.	<u>75 Crash Hazard</u>	<u>50 Crash Hazard</u> (Chance of partial power failure and stalls less than twin-engine aircraft, but greater potential damage.)	<u>200 Crash Hazard</u> (Greater chance of power failure and stalls and greater potential damage.)
<u>Area D</u>	Instrument landing runways only. Under instrument weather conditions, malfunctioning of any of the equipment that the pilot uses during the approach can cause a crash in this area before the trouble is noticed.	<u>100 Crash Hazard</u>	<u>125 Crash Hazard</u> (Greater damage potential because of size, speed, etc.)	<u>400 Crash Hazard</u> (Much greater damage potential because of possibility of flame-out, stalls, and greater speed and size.)

Source: Cornell Aeronautical Laboratory, Inc., Airports and Their Use, Report No. JA-807-B, pages VI(a)-1 through VI(a)-5.

Table 3. Bases for Delineating Boundaries of Crash Hazard Area
for Aircraft Take-offs (See Figures 4, 5, and 6)

Area	Aircraft Performance and Operational Characteristics	Twin- Engine Aircraft	Four-Engine Commercial and Jet Aircraft	Military Jet Aircraft
<u>Area E</u>	In case of engine failure before the aircraft reaches sufficient speed, the pilot can make a turn up to 30 degrees to select the safest spot for landing in this area.	<u>100 Crash Hazard</u>	<u>75 Crash Hazard</u> (Less chance of partial or complete power failure but greater potential damage.)	<u>400 Crash Hazard</u> (Greater chance of power failure, etc., and greater potential damage with greater aircraft speed, weight, and flammability. Area fans out to left since military aircraft often start their turn after take-off earlier [see Fig. 6] than commercial aircraft which must be careful not to disturb passengers.)
<u>Area F</u>	In case of engine failure after the aircraft reaches sufficient speed, the aircraft will land in this area if it cannot go around for a landing at the airport.	<u>50 Crash Hazard</u>	<u>25 Crash Hazard</u> (Less chance of partial or complete power failure because of number of engines, but greater potential damage.)	<u>200 Crash Hazard</u> (Greater chance of partial power failure and greater potential damage with speed, weight, and flammability. Area also fans out to left see Fig. 6).

Source: Cornell Aeronautical Laboratory, Inc., Airports and Their Use, Report No. JA-807-B, pages VI(a)-1 through VI(a)-5.

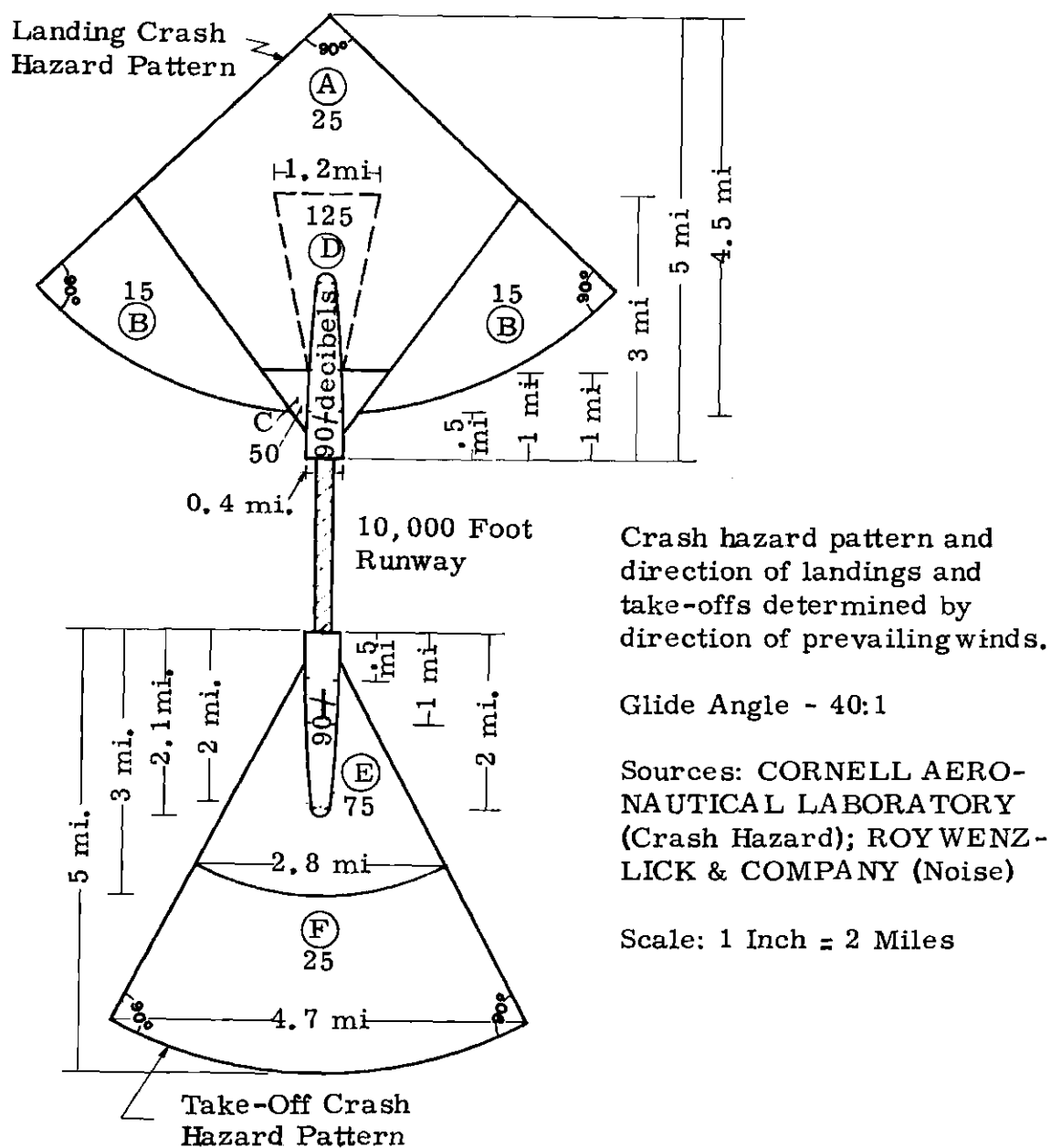


FIGURE 4 - AIRCRAFT CRASH HAZARD AND
AND NOISE INTENSITY AREAS, FOUR-ENGINE
COMMERCIAL JET AND PROPELLER
AIRCRAFT

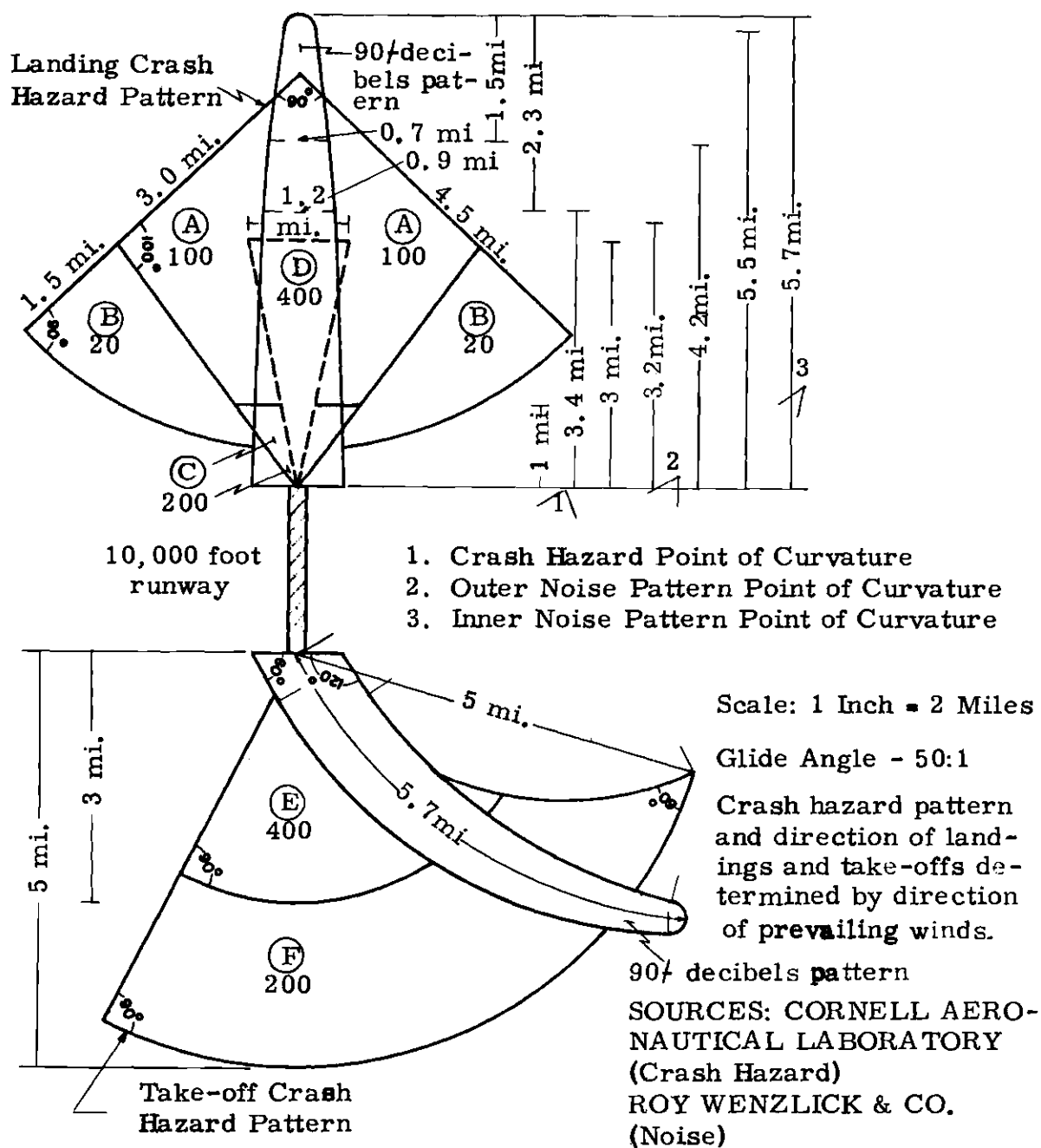


FIGURE 5 - AIRCRAFT CRASH HAZARD AND
NOISE INTENSITY AREAS, MILITARY JET
AIRCRAFT

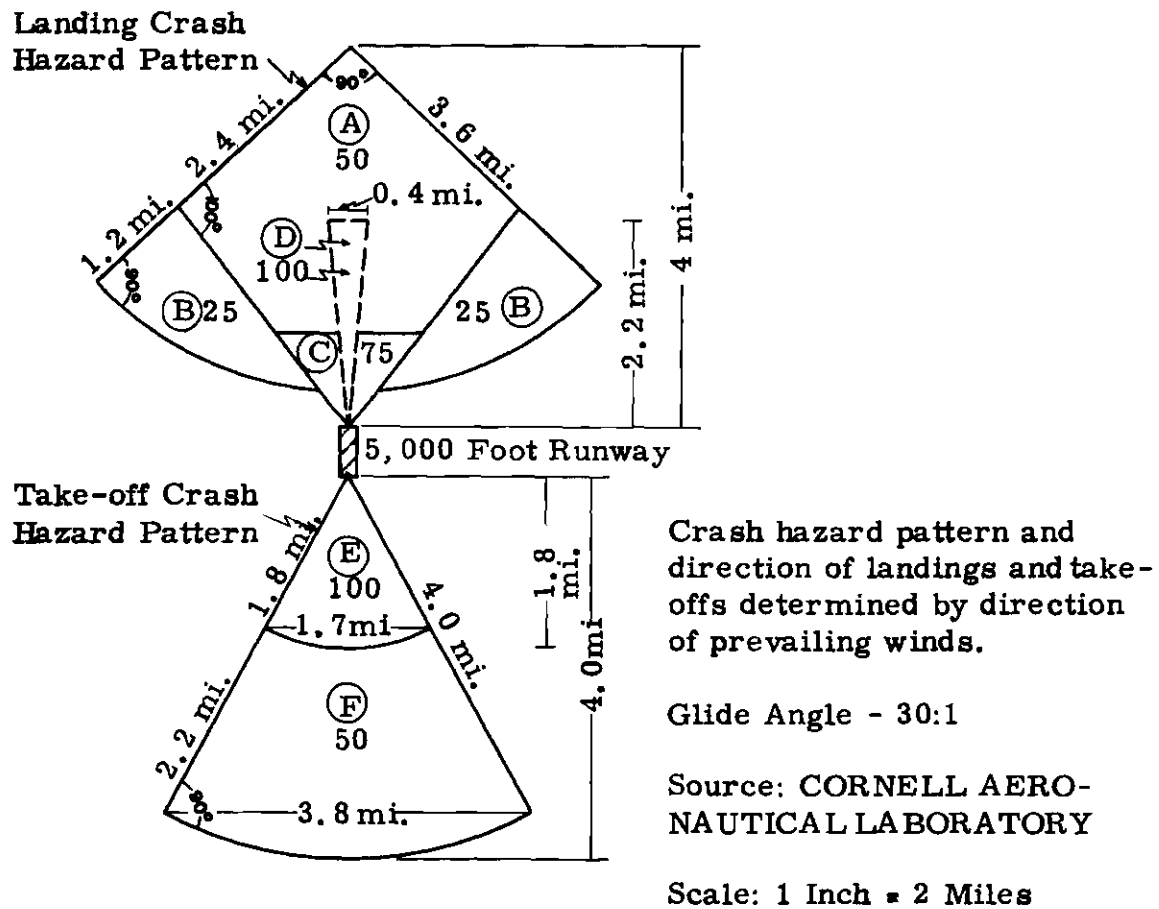


FIGURE 6 - AIRCRAFT CRASH
HAZARD AREAS,
TWIN-ENGINE AIRCRAFT

The crash hazard areas shown for four-engine commercial and military aircraft were made approximately 25 per cent larger than for twin-engine aircraft by the Cornell Aeronautical Laboratory upon consideration of wing loadings, power loadings and general aircraft handling characteristics.

Although these estimates of crash hazard damage potential might conceivably be challenged, they are the best estimates available at this time for such a complicated and variable subject. Future research by aeronautical engineers may alter these hazard area boundaries, at which time adjustments should be made to the templates presented in this study.

Land-Use Classification Within Airport Approach Areas

Desirable land uses have never been recommended for specific areas within airport approaches in relation to the crash hazard damage potential or noise intensity annoyance of various types of aircraft. The development of a technique to classify land uses for areas in airport approaches should achieve the following goals: (1) provide compatible and/or complementary land uses in the appropriate locations in the airport approaches; and (2) lower or restrict the population density (residents, shoppers, employees, or public assembly occupants [in schools, auditoriums, churches, etc.]) as the aircraft damage potential or annoyance increases in the airport approaches.

The crash hazard and noise intensity areas shown in Figures 4, 5, and 6 for the airport approaches of the three types of aircraft will next be analyzed as to their desirable land use. In order to simplify this analysis, crash hazard and noise intensity areas are grouped into four categories of damage potential or annoyance -- I, minimal; II, limited; III, considerable; and IV, extreme. These areas are classified as follows:

- I. Minimal.-- Those areas with a crash hazard index ranging from 12 to 50 where the damage potential is so minor as to permit normal residential or any other land-use development, including places of public assembly.
- II. Limited.-- Those areas with a crash hazard index ranging from 51 to 100 where the damage potential is sufficient to justify only low-density residential or other land-use development, but not including places of public assembly.
- III. Considerable.-- Those areas with a crash hazard index ranging from 101 to 200 where the damage potential is great enough to be dangerous to all land uses except those allied to airports or of an open type.
- IV. Extreme.-- Those areas with a crash hazard index ranging from 201 to 400 where the damage potential dictates that human beings be restricted from

residences, employment, or assembly and the land left to an open or natural-corridor use. Those areas with a noise intensity of 90 decibels or more would also be included in this classification.

These areas are shown on Figures 7, 8, and 9.

Certain desirable land uses are specified for these four classifications. Among these are natural-corridor uses (rivers, swamps, etc.), open land uses (passive recreation areas, truck farming, etc.), and airport-allied uses (air freight terminals, aviation schools, etc.), which are covered more completely in Table 4.

Desirable Land Uses Within Airport Approach Areas

Certain land uses other than normal residential, commercial, industrial, and public land uses are more desirable in the four designated areas in the airport approaches. These are as follows:

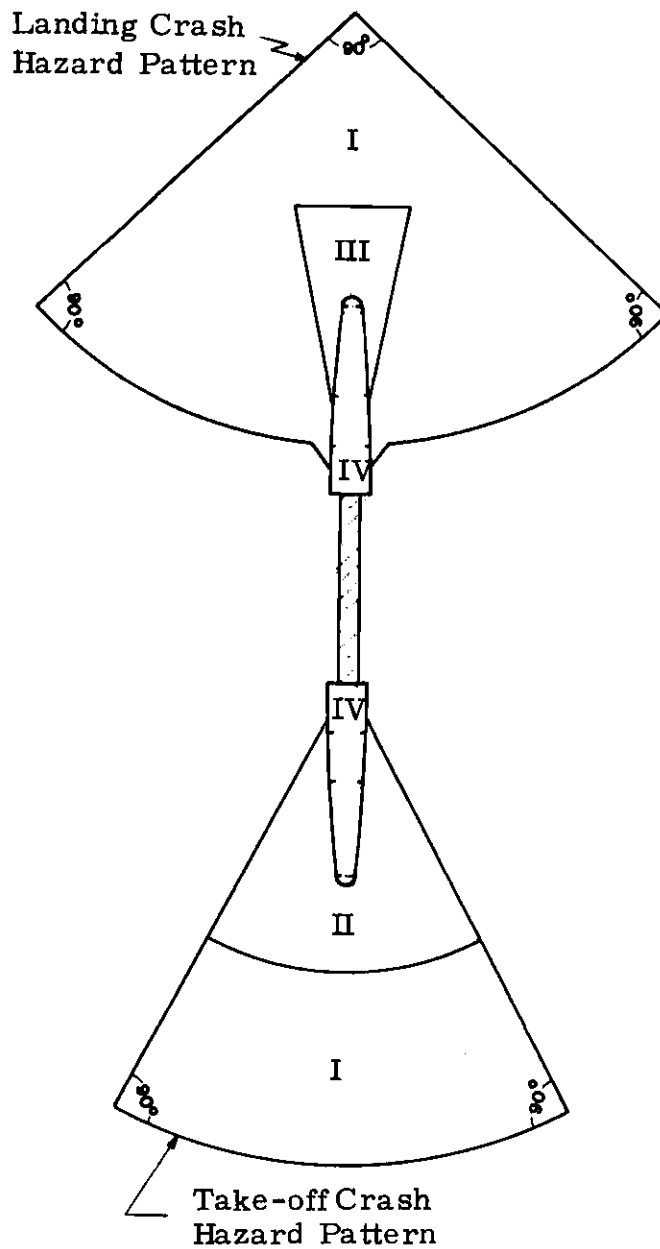
Table 4. Desirable Land Uses for Airport Approaches

<u>Natural-Corridor Uses</u>	<u>Airport-Allied Uses</u>
1. Rivers, lakes and streams	1. Aircraft & aircraft parts manufacturers
2. Swamps	2. Air-freight terminals
3. Areas subject to flooding	3. Trucking terminals & other allied uses
4. Other forms of unpopulated land	4. Aviation schools
	5. Aircraft-repair shops
	6. Warehouses
	7. Aerial survey & other similar companies
	8. Aviation research & testing laboratories
	9. Airline schools
	10. Auto storage areas
	11. Parking lots
	12. Airport motels & hotels
	13. Restaurants
	14. Taxi & bus terminals
	15. Wholesale distribution centers
	16. Gas stations
<u>Open Land Uses</u>	
1. Cemeteries	
2. Reservoirs	
3. Reservations	
4. Game preserves	
5. Forests	
6. Water-treatment plants	
7. Sewage-disposal plants	
8. Sod farming	
9. Truck farming	
10. Other vegetable & plant crop cultivation	
11. Landscape nurseries	
12. Golf courses	
13. Riding academies	
14. Picnic areas	

These desirable land uses were then applied to the four classifications. Table 5 shows recommended land usage in areas within airport approaches.

Table 5. Recommended Land Use for Crash Hazard and Noise Intensity Areas Within Airport Approaches

Area	Crash Hazard Damage Potent- tial Range	Noise Inten- sity Annoy- ance Range	Recommended Land Uses
Area I having <u>minimal</u> crash hazard damage potential	12- 50	---	<ol style="list-style-type: none"> 1. Medium density resi- dential with a den- sity of not under 6,000 square feet per dwelling unit. 2. Commercial 3. Industrial 4. Places of public assembly 5. Natural-corridor and open land uses
Area II having <u>limited</u> crash hazard damage potential	51-100	---	<ol style="list-style-type: none"> 1. Low density residen- tial development not under one acre per dwelling unit. 2. Commercial 3. Industrial 4. Natural-corridor and open land uses
Area III having <u>considerable</u> crash hazard damage poten- tial	101-200	---	<ol style="list-style-type: none"> 1. Airport-allied indus- try and other industry having five or fewer employees per acre. 2. Natural-corridor uses 3. Open land uses
Area IV having <u>extreme</u> crash hazard damage potential or extreme noise of 90 decibels or more	201-400	90+	<ol style="list-style-type: none"> 1. Natural-corridor uses 2. Open land uses



See Figure 4 for Exact Dimensions of Pattern

Scale: 1 Inch = 2 Miles

FIGURE 7 - RECOMMENDED LAND USE
AREAS WITHIN AIRPORT APPROACHES,
FOUR-ENGINE COMMERCIAL JET AND
PROPELLER AIRCRAFT

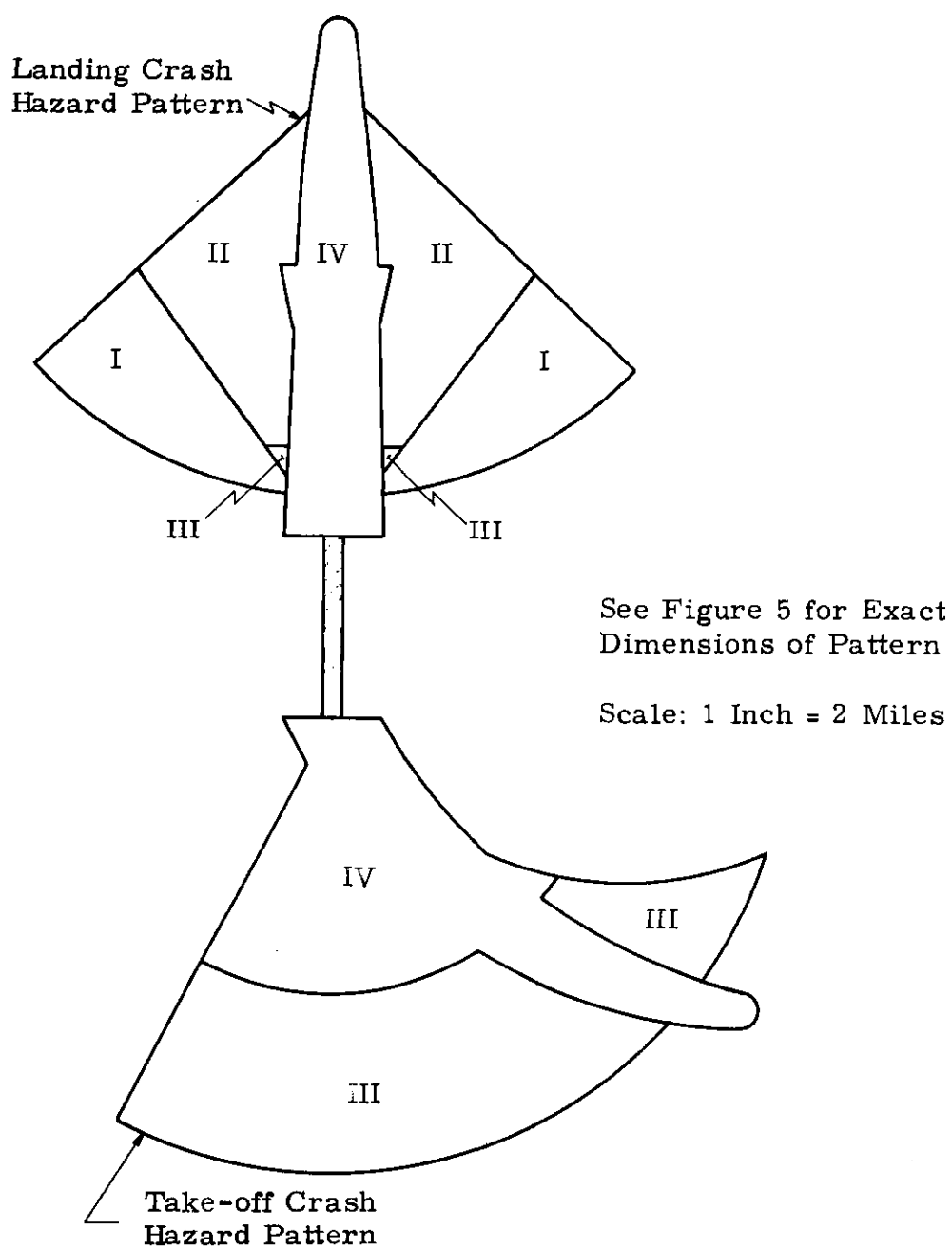
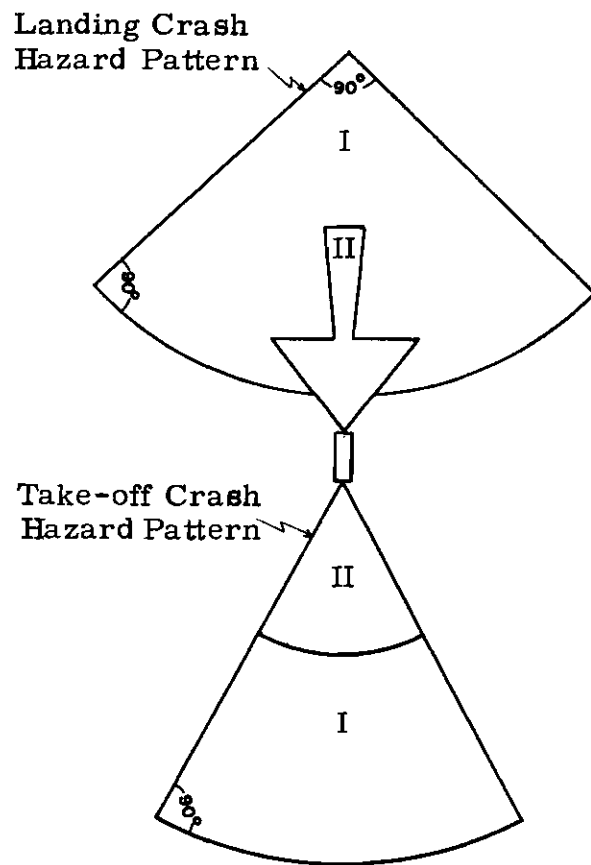


FIGURE 8 - RECOMMENDED LAND USE
AREAS WITHIN AIRPORT APPROACHES,
MILITARY JET AIRCRAFT



See Figure 6 for
Exact Dimensions of Pattern

Scale: 1 Inch = 2 Miles

FIGURE 9 - RECOMMENDED LAND USE
AREAS WITHIN AIRPORT APPROACHES,
TWIN-ENGINE AIRCRAFT

The location in Areas I, II, III, and IV, listed in Table 5, are shown in the airport approaches for the three types of aircraft in Figures 7, 8, and 9.

Summary

In an attempt to improve on existing airport approach area policy, two techniques were utilized which measured: (1) crash hazard damage potential, and (2) noise intensity annoyance for three basic types of aircraft. Aircraft performance and operational characteristics were utilized to measure crash hazard damage potential for twin-engine, four-engine commercial jet and propeller, and military jet aircraft. Noise intensities of 90 decibels or more were found to have a significant effect on residential land values. Areas with a noise intensity of 90 decibels or more were delineated for commercial and military aircraft. Four land-use classifications were recommended for crash hazard and noise intensity areas within airport approaches for the three types of aircraft, covering minimal, limited, considerable, and extreme damage or annoyance potential. It was recommended that, in areas with considerable or extreme hazard or annoyance, land use should be limited to open land, natural-corridor, and airport-allied uses. Finally, recommended land uses within different segments of airport approaches were developed for the three types of aircraft.

CHAPTER V

RECOMMENDATIONS

The control and protection of land uses in the vicinity of airports are necessary to reduce annoyance and hazard to residents and to protect airport operational capabilities. If this is properly done, compatible land-use development will take place around airports and aviation can more easily continue its rapid development as an important mode of transportation.

Urban Planning.--It is recommended that all cities desiring to control and protect land uses in the vicinity of airports begin by analyzing the aviation problems with which they are already confronted in their urban areas. Urban planning studies, including population predictions, directional trends of urban growth, urban area economic potential, future land-use patterns, etc., should be utilized by the planning staff as background material. An airport economic potential study should then be undertaken to determine the future demand for air traffic, airports, and airport space requirements.

An airport development advisory committee should then be established to formulate policies that will protect both existing and future airports and their surrounding land

uses. This committee should be composed of representatives from the governmental bodies and planning staffs of all local governments in the affected region; private, commercial, and military aviation organizations; and from the Civil Aeronautics Administration. This committee should establish policies concerning: (1) airport specialization; (2) the shape and size of all airport approach areas as determined by the volume of noise and the degree of crash hazard; (3) desirable land uses for approach areas and areas adjacent to all airports; (4) minimum distances between airports; (5) the utilization of single or parallel runway systems by all airports; and (6) the use of foliage, building, and land-use buffer screens to reduce ground operational noise at all airports.

Utilizing these policy determinations, the area's planning staff should prepare a metropolitan or regional airport study to determine the future location of airports in relation to each other, to their aircraft users and owners, and to the future land-use plan. Using the findings of the airport advisory committee, individual airport site plans should be developed to guide the improvement of existing airports and the development of proposed airports.

Public Relations.--A very important step which should be taken early in the airport planning program is to educate the public to adjust to the annoyance and hazard created by

aircraft. Even the best planning program cannot entirely eliminate these problems. People must become cognizant of the fact that:

No one is entitled to absolute quiet in the enjoyment of his property; he may only insist upon a degree of quietness consistent with the standard of comfort prevailing in the locality in which he dwells.⁶³

Close liaison should be maintained with the school board in order to prevent the location of future schools within approach areas. Similar relationships should be established with the recreation department in order to encourage the location of passive recreational sites and other public and private open-land uses (golf courses, cemeteries, landscape nurseries, etc.) within the approach areas and to discourage the location of intensively used active recreational sites (playgrounds, playfields, stadiums, etc.) within airport approach areas.

As land begins to develop around the airport, meetings should be held with the land owners to explain why certain land uses are desirable within the approach areas or adjacent to the airport. Certain land uses which are compatible with airport operations and which will give a fair return on the owner's investment should be suggested.

Meetings with church groups, shopping center developers, and other groups planning public assembly structures around airports should be held also to explain why these uses within

approach areas would be adversely affected by airport operations.

Legal Tools.--Through the guidance of the Model Airport Zoning Act and Ordinance and the authority of state enabling legislation, airport zoning should be formulated for all airports and their approach areas as an integral part of comprehensive zoning. This would insure that the areas surrounding airports will be properly buffered by compatible land uses. All proposed airport sites should be purchased or reserved. This would encourage the zoning of the airport approaches and adjacent undeveloped areas in advance of development to prevent future conflicts between airports and their surrounding land uses.

Reservation of public open space and public building sites can be guided through subdivision plat control. Through subdivision regulations, proper subdivision design and location can be assured in the vicinity of airports.

Whenever necessary, eminent domain proceedings should be initiated to insure that there will not be a taking of property within airport approach areas without compensation. Either outright purchase of land in fee or purchase of developmental rights should be accomplished while the land is still undeveloped and less expensive.

Emphasis has been placed on the use of the entire urban planning process to facilitate the compatible co-

existence of airports with their surrounding land uses. Airports which were developed in the past without overall planning have created serious conflicts with surrounding developments. To prevent more complex problems from occurring in the future, urban planning should be utilized now to promote the harmonious development of existing airports and their surrounding land uses. Planning should be undertaken also in connection with new airports. Such action would permit aviation to assume its logical position as a leader in the transportation field.

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